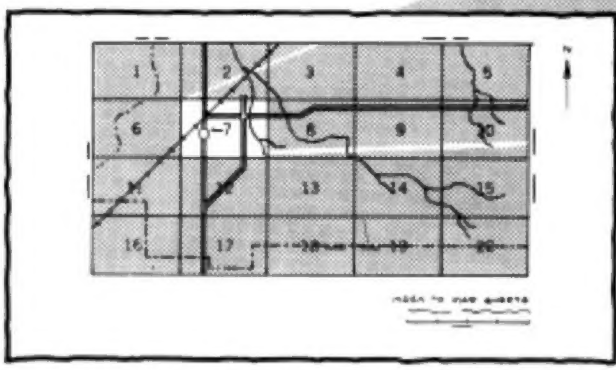
Soil Survey of

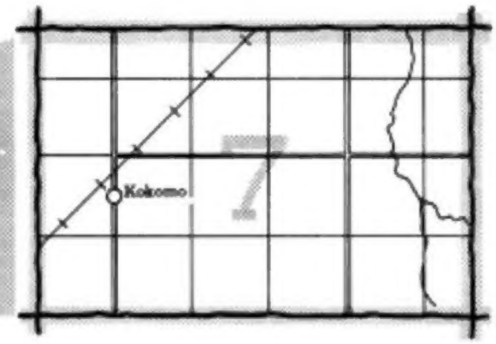
Montgomery County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

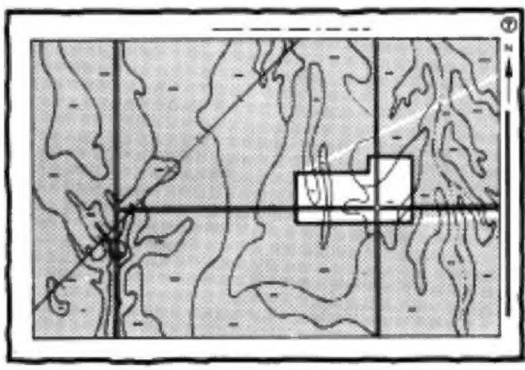
1. Locate your area of interest on the "Index to Map Sheets"

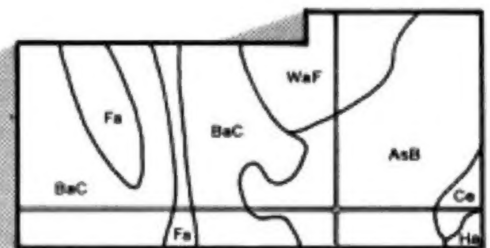




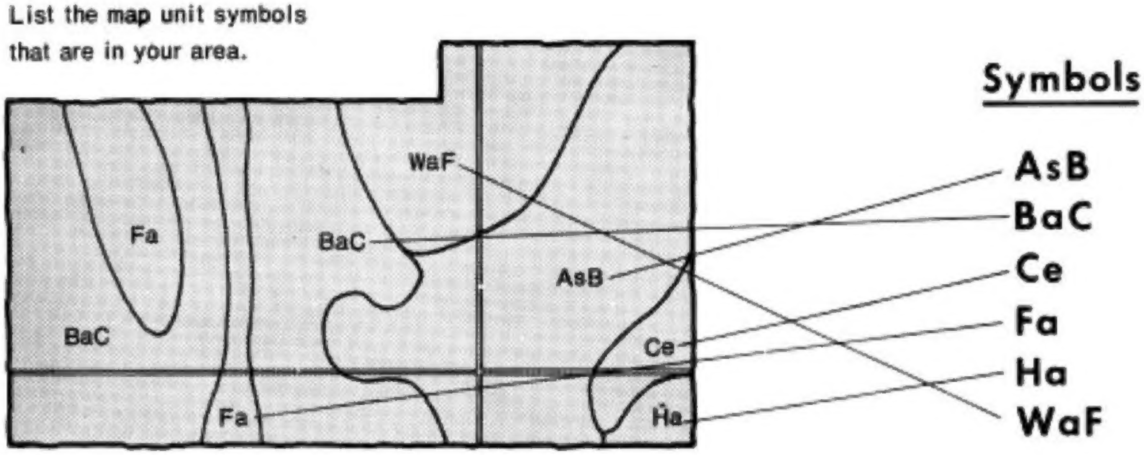
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



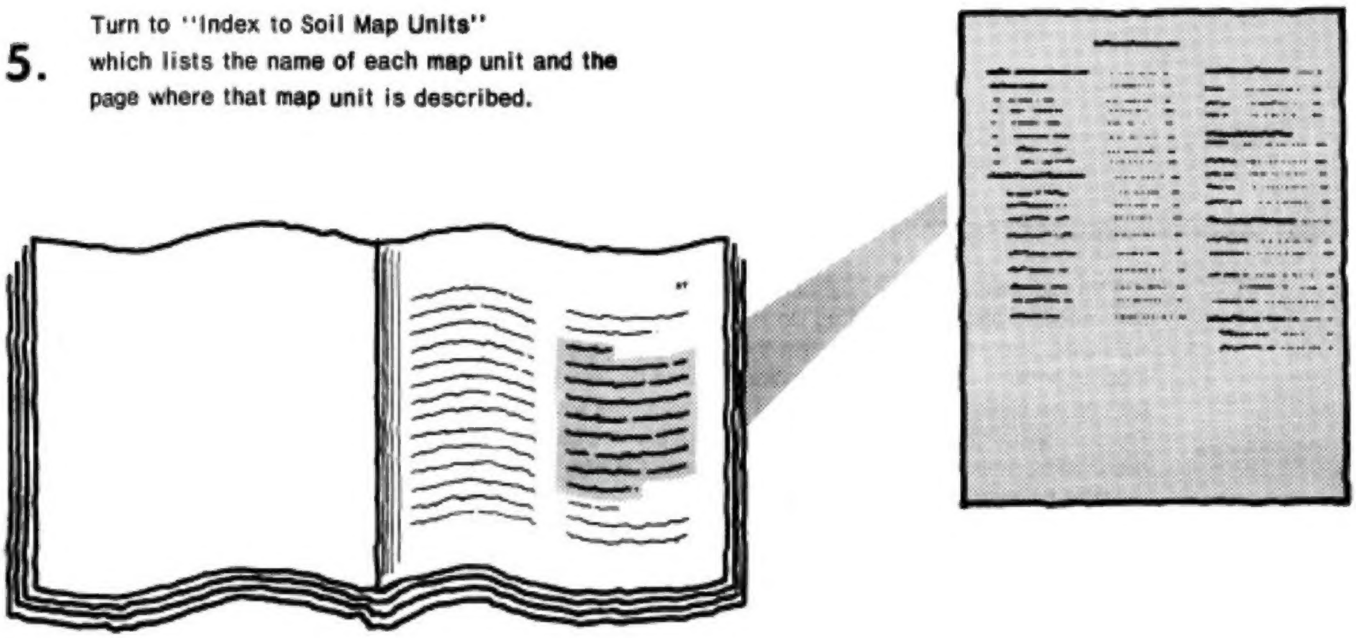


4. List the map unit symbols that are in your area.

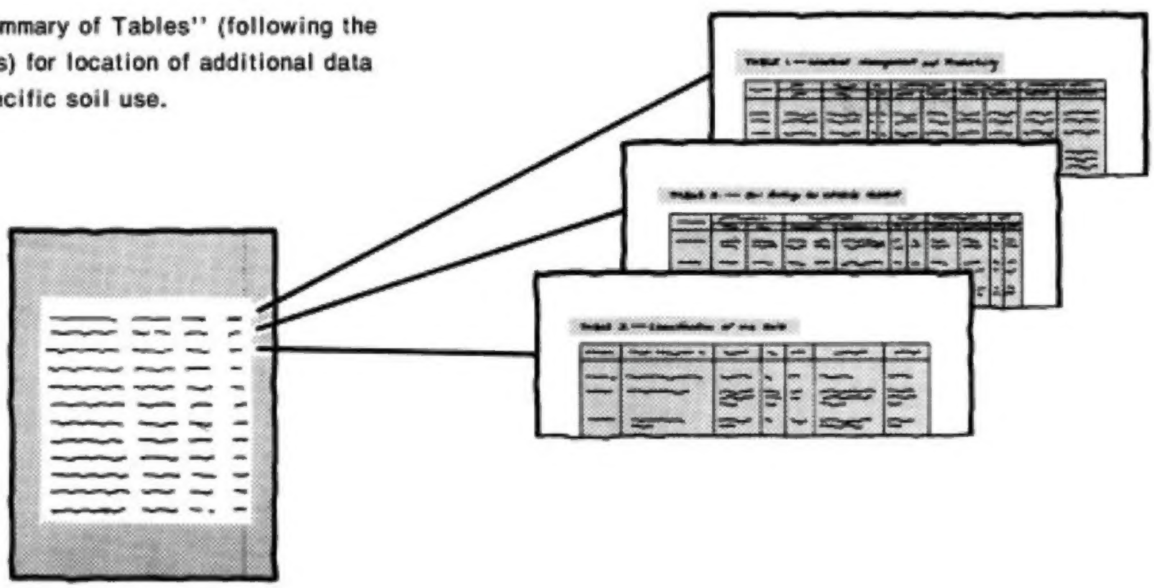


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Montgomery County Conservation District. Major fieldwork was performed in the period 1965-77. Soil names and descriptions were approved in 1978. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Range and pasture in an area of Eram-Talihina silty clay loams, 6 to 20 percent slopes.

contents

soil series

Issued December 1980

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summary of tables

foreword

This soil survey contains information that can be used in land-planning programs in Montgomery County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service

soil survey of
Montgomery County, Kansas

By Edward L. Fleming and Howard V. Campbell, Soil Conservation Service

Fieldwork by Edward L. Fleming, Howard V. Campbell, Cleveland E. Watts, and Paul R. Kutnink, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Kansas Agricultural Experiment Station

general nature of the county

MONTGOMERY COUNTY is in southeastern Kansas (fig. 1). It is bordered on the south by Oklahoma. It has a total land area of 401,920 acres, or 628 square miles. The population was 43,948 in 1978. Independence is the county seat. The county was organized in 1869.

Most of Montgomery County is in the Cherokee Prairie land resource area. The soils generally are nearly level to moderately sloping but are steeper along entrenched drainageways. They generally are deep or moderately deep and have a loamy or clayey subsoil. Elevation ranges from 700 to 1,066 feet above sea level.

Most of the county is drained by the Verdigris and Elk Rivers and their tributaries. These streams flow in a southerly direction.

Farming is the main enterprise. Small industries also are important. The climate favors cash grain and livestock farming. The main crops are wheat, grain sorghum, and soybeans.

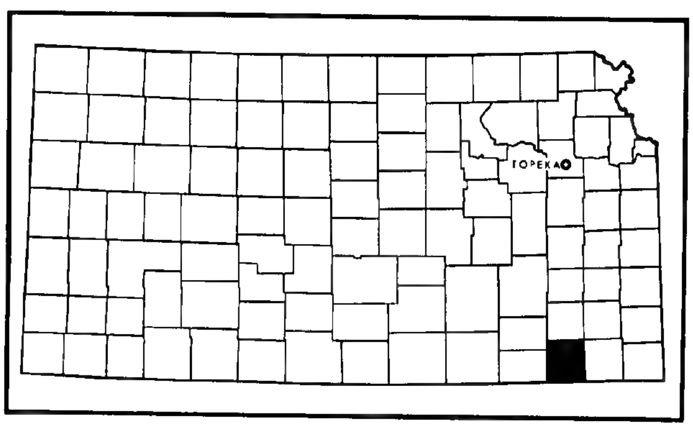

Figure 1.—Location of Montgomery County in Kansas.

This soil survey updates an older soil survey of Montgomery County, which was published in 1915 (*3*). It provides additional information and larger maps that show the soils in greater detail.

climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Montgomery County is typical continental, as can be expected of a location in the interior of the large land mass in the middle latitudes. Such climates are characterized by large daily and annual variations in temperature. Winters are cold because of the frequent outbreaks of polar air. They last from December to February. Summer lasts for about 6 months every year. The warm temperatures provide a long growing season for the crops grown in the county. Spring and fall generally are short.

Montgomery County is in the path of a current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it falls during late-evening or nighttime thunderstorms. Although the total precipitation generally is adequate for any crop, its distribution causes problems in some years. Dry periods of several weeks are common during the growing season. A surplus of precipitation often results in muddy fields, which delay planting and harvesting.

Tornadoes and severe thunderstorms occur occasionally. These storms usually are local in extent and of short duration, so that the risk of crop damage is small. Hail falls infrequently during the warmer part of the year. It also is of local extent. It causes less crop damage in this county than the hailstorms in western Kansas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Independence in the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 36.8 degrees F, and the average daily minimum temperature is 26.0 degrees. The lowest temperature on record, which occurred at Independence on February 13, 1945, is -23 degrees. In summer the average temperature is 78.4 degrees, and the average daily maximum temperature is 89.7 degrees. The highest temperature, which occurred at Independence on August 9, 1936, is 116 degrees.

The total annual precipitation is 36.95 inches. Of this, 26.01 inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 19.62 inches. The heaviest 1-day rainfall was 6.38 inches at Independence on July 2, 1976.

Average seasonal snowfall is about 11 inches. The greatest snow depth at any one time during the period of record was 19 inches. On an average of 15 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 70 percent of the time possible in summer and 55 percent in winter.

natural resources

Soil is the most important natural resource in the county. Also important are water, native grasses, timber, shale, limestone, oil, and gas.

The water for use on farms is drawn from wells, ponds, streams, and rural water district supply lines. The water for towns generally is drawn from streams and lakes.

Limestone is the most common mineral in the county. It is mined for use in the manufacturing of cement, brick, and agricultural lime. Oil and gas wells are throughout the county. Production from these wells is low.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

soil descriptions

1. Eram-Talihina association

Gently sloping to steep, moderately well drained, silty soils on uplands

This association is on low hills and on ridges that have short side slopes and narrow tops. Most areas are dissected by drainageways.

This association makes up about 20 percent of the county. It is about 50 percent Eram soils, 20 percent Talihina soils, and 30 percent minor soils (fig. 2).

The moderately deep Eram soils are on side slopes. Typically, the surface layer is very dark brown silty clay loam about 11 inches thick. The subsoil is firm silty clay about 21 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is grayish brown. Light olive brown shale is at a depth of about 32 inches.

The shallow Talihina soils are on ridgetops and the steeper side slopes. Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is dark grayish brown, firm silty clay about 7 inches thick. The substratum is light olive brown silty clay that contains common shale fragments. Light olive brown shale is at a depth of about 17 inches.

The minor soils in this association are the moderately deep, well drained Bates soils on ridgetops; the shallow, well drained Collinsville soils on the steeper side slopes; and the deep, moderately well drained Dennis soils on side slopes.

About 65 percent of this association is pasture or range. The rest generally is cultivated. The main management needs are measures that keep the range in good condition, control erosion, and improve tilth and fertility.

2. Catoosa-Kenoma-Zaar association

Nearly level and gently sloping, well drained to somewhat poorly drained, silty and clayey soils on uplands

This association is on broad ridgetops and long side slopes. Most areas are dissected by drainageways.

This association makes up about 15 percent of the county. It is about 32 percent Catoosa soils, 30 percent Kenoma soils, 20 percent Zaar soils, and 18 percent minor soils (fig. 3).

The moderately deep, well drained Catoosa soils are on ridgetops and long side slopes. Typically, the surface layer is dark reddish brown silt loam about 10 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 21 inches thick. Hard limestone is at a depth of about 31 inches.

The deep, moderately well drained Kenoma soils are on broad ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is very dark grayish brown silt loam about 6 inches thick. The subsoil to a depth of about 60 inches is firm and very firm silty clay. The upper part is very dark grayish brown and dark yellowish brown and is mottled, and the lower part is dark brown.

The deep, somewhat poorly drained Zaar soils are on side slopes and along small drainageways. Typically, the surface layer is black silty clay about 6 inches thick. The subsurface layer is black silty clay about 8 inches thick. The subsoil is mottled, firm and very firm silty clay about 35 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is olive brown. The substratum to a depth of about 60 inches is mixed olive brown and dark yellowish brown silty clay.

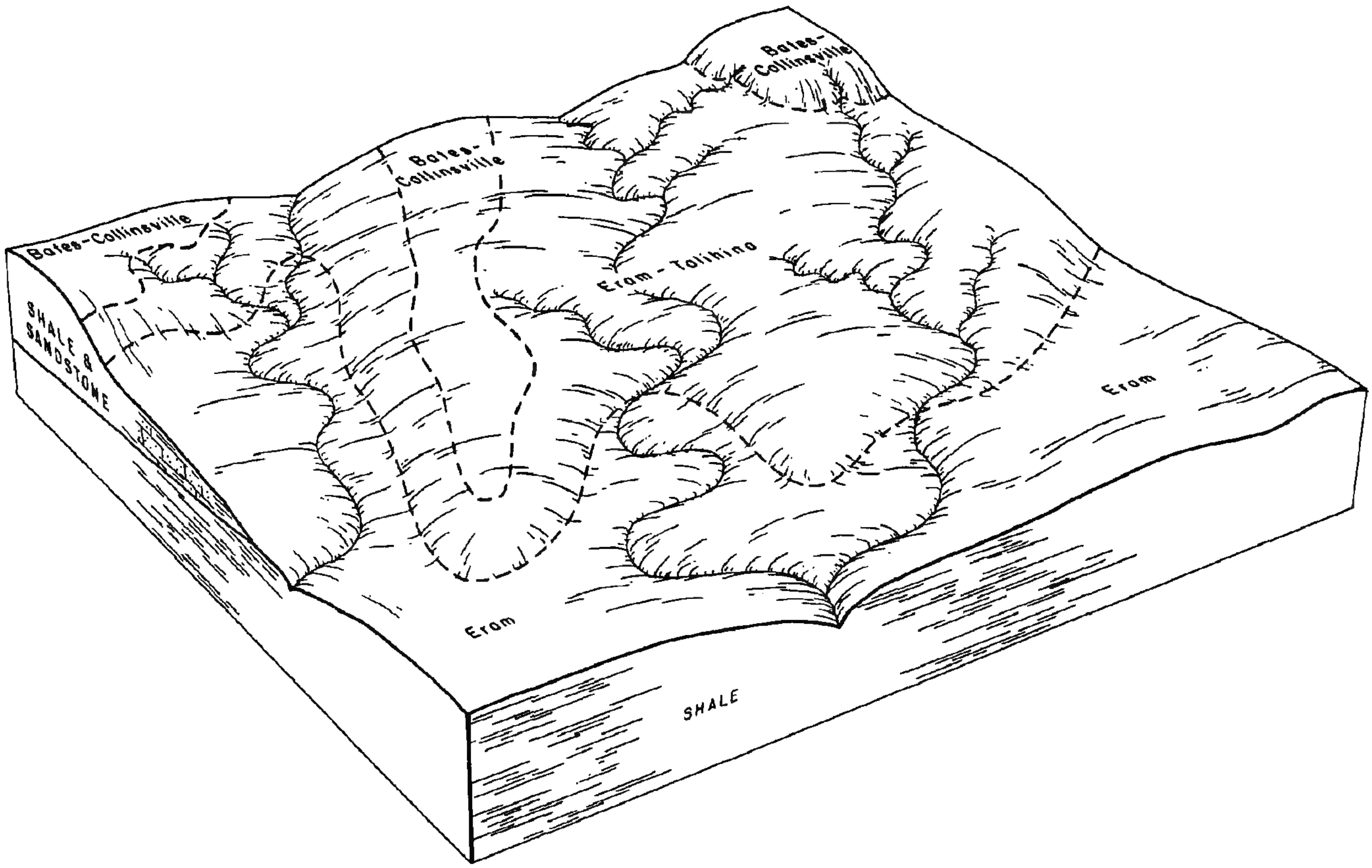

Figure 2.—Typical pattern of soils in the Eram-Talihina association.

The minor soils in this association are the moderately deep, moderately well drained Eram soils on side slopes; the shallow, well drained Shidler soils on limestone ridgetops; and the shallow, moderately well drained Talihina soils on the steeper side slopes. Shale outcrop is in areas of the Talihina soils.

About 60 percent of this association is used for the cultivated crops commonly grown in the county. The rest generally is pasture or range. The main management needs are measures that control erosion, improve tilth and fertility, and keep the range in good condition.

3. Kenoma-Woodson-Zaar association

Nearly level and gently sloping, moderately well drained and somewhat poorly drained, silty and clayey soils on uplands

This association is on broad ridges and flats and in swales. Most areas are dissected by shallow drainageways.

This association makes up about 15 percent of the county. It is about 42 percent Kenoma soils, 30 percent Woodson soils, 18 percent Zaar soils, and 10 percent minor soils (fig. 4).

The deep, moderately well drained Kenoma soils are on side slopes and ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer also is very dark grayish brown silt loam about 6 inches thick. The subsoil to a depth of about 60 inches is firm and very firm silty clay. The upper part is very dark grayish brown and dark yellowish brown and is mottled with strong brown, and the lower part is dark brown.

The deep, somewhat poorly drained Woodson soils are on broad flats. Typically, the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is black silt loam about 5 inches thick. The subsoil is very firm silty clay about 35 inches thick. The upper part is very dark gray, the next part is dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is dark gray silty clay mottled with yellowish brown.

The deep, somewhat poorly drained Zaar soils are in swales and drainageways. Typically, the surface layer is

black silty clay about 6 inches thick. The subsurface layer is black silty clay about 8 inches thick. The subsoil is mottled, firm and very firm silty clay about 35 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is olive brown. The substratum to a depth of about 60 inches is mixed olive brown and dark yellowish brown silty clay.

The minor soils in this association are the deep, moderately well drained Dennis soils. These soils are on side slopes.

Most of this association is used for the cultivated crops commonly grown in the county. Some areas are pasture or range. The main management needs are measures that control erosion and improve drainage, fertility, and tilth.

4. Bates-Dennis-Collinsville association

Gently sloping to moderately steep, well drained and moderately well drained, loamy and silty soils on uplands

This association is on low hills and on ridges that have short side slopes and narrow tops. Most areas are dissected by drainageways.

This association makes up about 36 percent of the county. It is about 35 percent Bates soils, 25 percent Dennis soils, 15 percent Collinsville soils, and 25 percent minor soils (fig. 5).

The moderately deep, well drained Bates soils are on ridgetops and side slopes. Typically, the surface layer is very dark brown loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone and sandy and silty shale are at a depth of about 27 inches.

The deep, moderately well drained Dennis soils are on side slopes. Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsoil to a depth of about 60 inches is dark brown. The upper part is friable silty clay loam, and the lower part is mottled, firm silty clay.

The shallow, well drained Collinsville soils are on the steeper side slopes and ridgetops. Typically, the surface layer is very dark grayish brown fine sandy loam about 11 inches thick. The substratum is dark yellowish brown fine sandy loam that contains many small sandstone fragments. Hard sandstone is at a depth of about 17 inches.

The minor soils in this association are the shallow, well drained Darnell soils on ridgetops; the moderately deep, moderately well drained Eram and moderately deep, somewhat poorly drained Niotaze soils on side slopes; and the shallow, moderately well drained Talihina soils on the steeper side slopes.

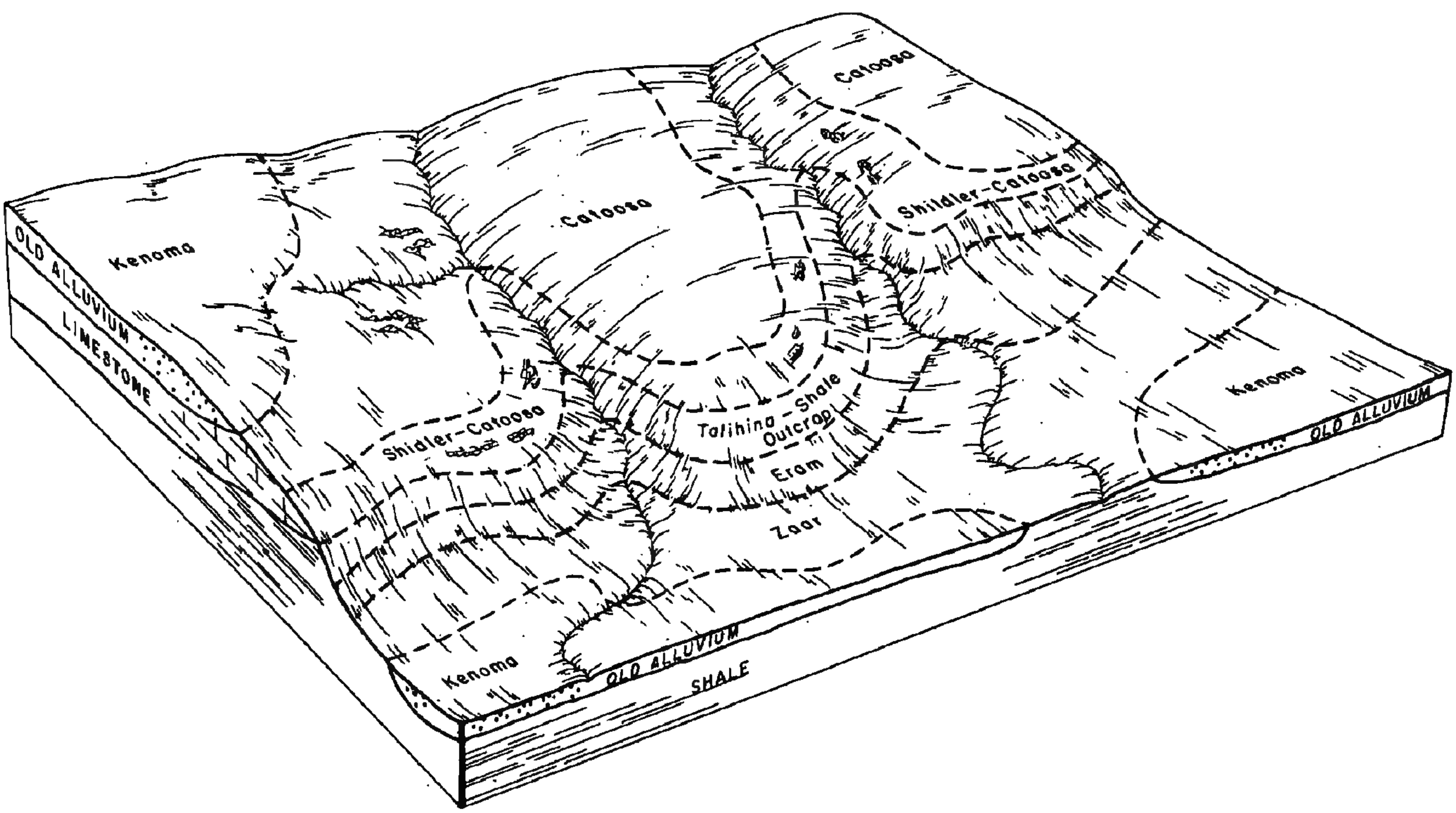

Figure 3.—Typical pattern of soils in the Catoosa-Kenoma-Zaar association.

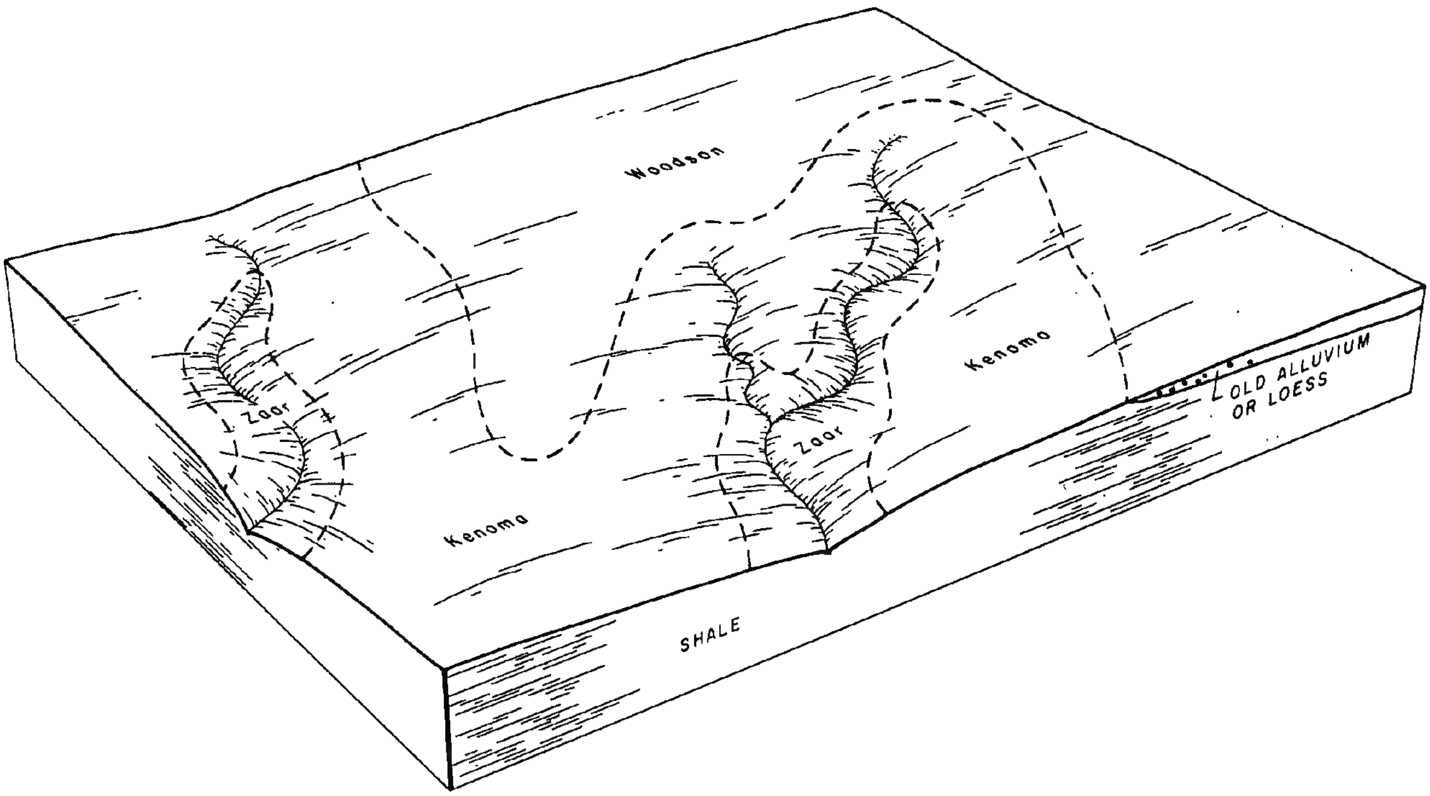

Figure 4.—Typical pattern of soils in the Kenoma-Woodson-Zaar association.

About 60 percent of this association is pasture or range. The rest generally is cultivated. The main management needs are measures that keep the range in good condition, control erosion, and improve tilth and fertility.

5. Verdigris-Osage-Lanton association

Nearly level, moderately well drained to poorly drained, silty and clayey soils on bottom land

This association is on flood plains and terraces in the valleys of the major streams and the larger drainageways. Most areas are subject to flooding.

This association makes up about 14 percent of the county. It is about 42 percent Verdigris soils, 24 percent Osage soils, 22 percent Lanton soils, and 12 percent minor soils.

The deep, moderately well drained Verdigris soils are on flood plains. Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is very dark brown silt loam about 21 inches thick. The next 18 inches is dark brown, friable silt loam. The substratum to a depth of about 60 inches is brown silt loam.

The deep, poorly drained Osage soils are on flood plains. Typically, the surface layer is very dark gray silty clay about 6 inches thick. The subsurface layer is black silty clay about 9 inches thick. The subsoil to a depth of about 60 inches is very dark gray, very firm and extremely firm silty clay.

The deep, somewhat poorly drained Lanton soils are on flood plains. Typically, the surface layer is very dark grayish brown silty clay loam about 12 inches thick. The subsurface layer is very dark gray, mottled, firm silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled silty clay loam and silty clay.

The minor soils in this association are the moderately well drained Dennis soils on foot slopes and the well drained Mason soils on the higher stream terraces that are rarely flooded. The Dennis soils are clayey throughout most of the subsoil.

Most of this association is used for the cultivated crops commonly grown in the county. Some areas support tame or native grass or trees. The main management needs are measures that prevent flooding and improve drainage, fertility, and tilth.

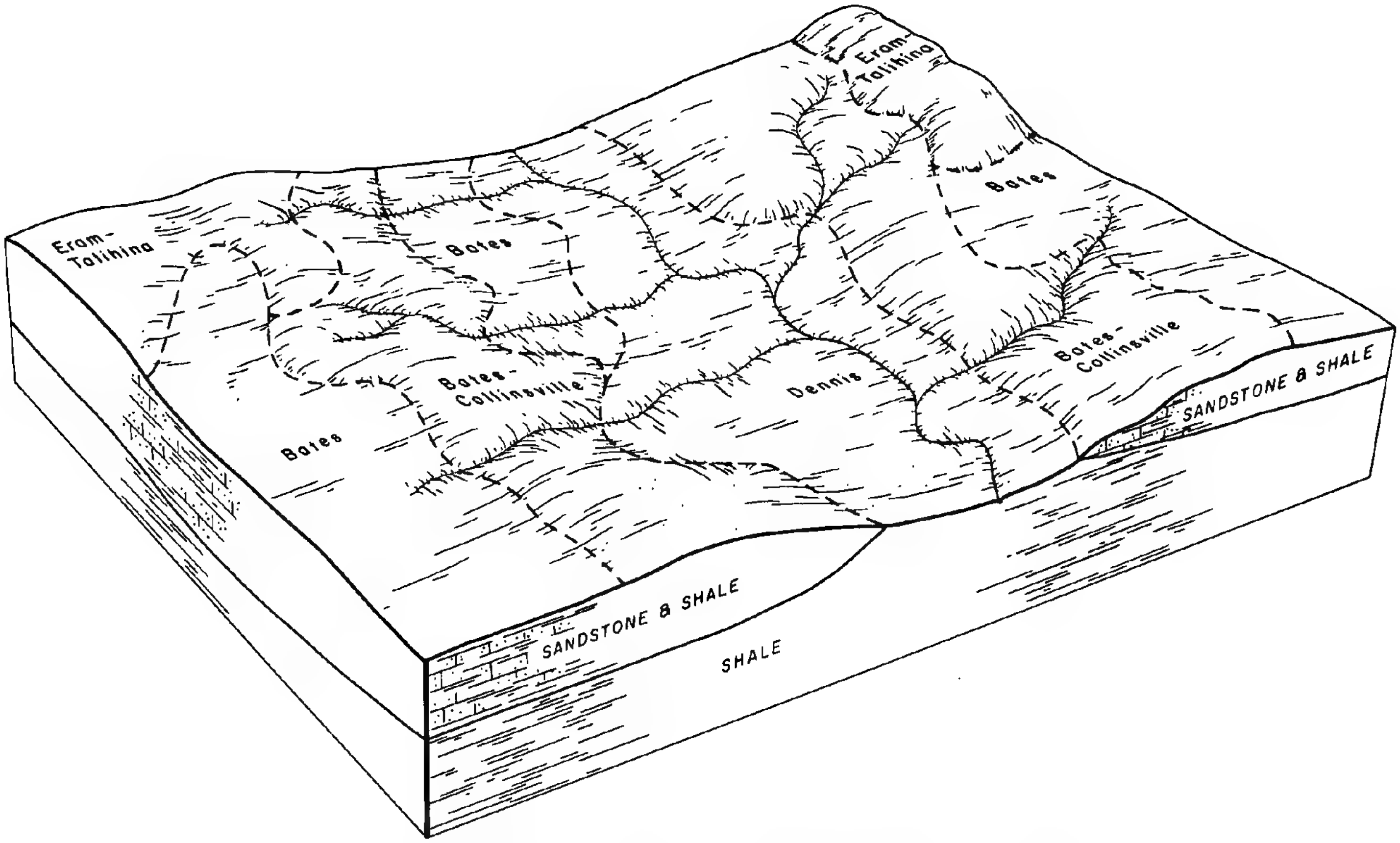

Figure 5.—Typical pattern of soils in the Bates-Dennis-Collinsville association.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Bates loam, 1 to 3 percent slopes, is one of several phases in the Bates series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Niotaze-Darnell complex, 8 to 20 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Quarries is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations and capabilities for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Ba—Bates loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is very dark brown loam about 9 inches thick. The subsoil is about 18 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone and sandy and silty shale are at a depth of about 27 inches (fig. 6). In places the surface layer and subsoil contain many sandstone fragments. In some small areas the lower part of the surface layer is grayish brown silt loam.

Included with this soil in mapping are small areas of Collinsville, Dennis, and Eram soils. The shallow Collinsville soils generally are more sloping than the Bates soil and are on ridgetops. The deep Dennis soils have a dominantly clayey subsoil. They are on side slopes. The moderately well drained Eram soils are on foot slopes. They have a clayey subsoil. Included soils make up 10 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. The surface layer is friable, and tilth is good. Root penetration is restricted below a depth of about 27 inches. Reaction is strongly acid to slightly acid in the

Figure 6.—Profile of Bates loam, 1 to 3 percent slopes. This soil is moderately deep over soft sandstone. Depth is marked in feet.

subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour (fig. 7).

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

This soil is suitable as a site for dwellings without basements and for local roads and streets. It generally is unsuitable, however, as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils are better sites for sewage lagoons.

The capability subclass is IIe.

Bb—Bates loam, 3 to 6 percent slopes. This moderately sloping, well drained soil is on the tops and sides of ridges in the uplands. Individual areas are irregularly shaped or long and narrow and range from 20 to 150 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsoil is about 17 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone and sandy and silty shale are at a depth of about 24 inches. In places the surface layer and subsoil contain many sandstone fragments. In some small areas the lower part of the surface layer is grayish brown silt loam.

Included with this soil in mapping are small areas of Collinsville, Dennis, and Eram soils. The shallow Collinsville soils generally are more sloping than the Bates soil and are on ridgetops. The deep Dennis soils have a dominantly clayey subsoil. They are on the lower side slopes. The moderately well drained Eram soils are on foot slopes. They have a clayey subsoil. Included soils make up 10 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. The surface layer is friable, and tilth is good. Root penetration is restricted below a depth of about 24 inches. Reaction is strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to soybeans, grain sorghum, corn, wheat, and tall fescue.

Figure 7.—Contour farming along terraces in an area of Bates loam, 1 to 3 percent slopes.

Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

This soil is suitable as a site for dwellings without basements and for local roads and streets. It generally is unsuitable, however, as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils are better sites for sewage lagoons.

The capability subclass is IIIe.

Bc—Bates loam, 2 to 6 percent slopes, eroded. This moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Erosion has removed most of the original surface layer. Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is dark brown, firm clay loam about 16 inches thick. Soft sandstone and sandy and silty shale are at a depth of about 21 inches. In places the surface layer is clay loam. In some small areas it is more than 5 inches thick and is very dark brown. In some areas the surface layer and subsoil contain many sandstone fragments.

Included with this soil in mapping are small areas of Collinsville and Eram soils. The shallow Collinsville soils generally are more sloping than the Bates soil and are on ridgetops. The moderately well drained Eram soils have a clayey subsoil. Their positions on the landscape are similar to those of the Bates soils. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the Bates soil. Available water capacity is low. Surface runoff is medium. Natural fertility is low. The content of organic matter is moderately low. The surface layer is firm, and tilth is poor. Root penetration is restricted below a depth of about 21 inches. Reaction is strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

About half the acreage is cultivated. The rest generally is abandoned cropland or tame grass pasture. This soil is suited to soybeans, grain sorghum, corn, wheat, and tall fescue. It is somewhat droughty, however, and crops tend to wilt during hot periods. Measures that control erosion, improve tilth, and increase the content of

organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to native range and tame grass pasture. The major concerns of management are undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds, brush, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

This soil is suitable as a site for dwellings without basements and for local roads and streets. It generally is unsuitable, however, as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The less sloping, deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is IVe.

Bf—Bates-Collinsville complex, 1 to 4 percent slopes. These gently sloping, well drained soils are on the tops of ridges in the uplands. The Collinsville soil generally is more sloping than the Bates soil. Individual areas are long and narrow or irregularly shaped and range from 20 to 400 acres in size. They are about 50 percent Bates soil and 40 percent Collinsville soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone and sandy and silty shale are at a depth of about 25 inches. In places the surface layer and subsoil contain many sandstone fragments. In some small areas the lower part of the surface layer is grayish brown silt loam.

Typically, the Collinsville soil has a surface layer of very dark grayish brown fine sandy loam about 11 inches thick. The substratum is dark yellowish brown fine sandy loam that contains many small sandstone fragments. Sandstone bedrock is at a depth of about 17 inches. In places the surface layer contains many sandstone fragments. In some small areas it is grayish brown silt loam.

Included with these soils in mapping are small areas of the moderately well drained Eram and Talihina soils, both of which have a clayey subsoil. Eram soils are on the upper side slopes, and Talihina soils are on the steeper side slopes. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and very low in the Collinsville soil. Surface runoff is medium on both soils. Reaction is strongly acid to slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted at a depth of about 25 inches in the Bates soil and 17 inches in the Collinsville soil.

About half the acreage is cultivated. The rest generally is native range or tame grass pasture. These soils are suited to soybeans, grain sorghum, wheat, and tall fescue. Measures that control erosion, improve tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour. Terracing is difficult, however, on the shallow Collinsville soil.

These soils are well suited to native range and tame grass pasture. The major concerns of management are undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The Bates soil is suitable as a site for dwellings without basements and for local roads and streets. The Collinsville soil is not suitable as a site for dwellings and local roads and streets, however, because the depth to rock is a severe limitation. Both soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is IVe.

Bg—Bates-Collinsville complex, 4 to 20 percent slopes. These moderately sloping to moderately steep, well drained soils are on the sides and tops of ridges in the uplands. The Collinsville soil generally is more sloping than the Bates soil. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 45 percent Bates soil and 40 percent Collinsville soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 8 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Soft sandstone and sandy and silty shale are at a depth of about 27 inches. In places the surface layer and subsoil contain many sandstone fragments. In some small areas the lower part of the surface layer is grayish brown silt loam.

Typically, the Collinsville soil has a surface layer of very dark grayish brown fine sandy loam about 11 inches thick. The substratum is dark yellowish brown fine sandy loam that contains many small sandstone fragments. Sandstone bedrock is at a depth of about 17 inches (fig. 8). In places the surface layer contains many sandstone fragments. In some small areas it is grayish brown silt loam.

Included with these soils in mapping are small areas of Dennis, Eram, and Talihina soils, all of which have a clayey subsoil. The deep Dennis soils are on the lower side slopes. The moderately well drained Eram soils are on foot slopes. The moderately well drained Talihina soils are on the steeper side slopes. They are less than 20 inches deep over shale. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and very low in the Collinsville soil. Surface runoff is rapid on both soils. Reaction is strongly acid to slightly acid throughout the soils. Root penetration is restricted at a depth of about 27 inches in the Bates soil and 17 inches in the Collinsville soil.

These soils generally are unsuitable for cultivation. Erosion is a hazard if cultivated crops are grown.

Most areas are used as native range. These soils are well suited to native range and tame grass pasture. The major concerns of management are undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The Bates soil is suitable as a site for dwellings without basements and for local roads and streets. The Collinsville soil is not suitable as a site for dwellings and local roads and streets, however, because the depth to rock is a severe limitation. Both soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. Also, the slope is a severe limitation on sites for sewage lagoons. The less sloping, deeper included or adjacent soils are better sites for sewage lagoons.

The capability subclass is VIe.

Figure 8.—Profile of Collinsville fine sandy loam, a shallow soil that formed in sandstone. Depth is marked in feet.

Bu—Bates-Urban land complex, 2 to 6 percent slopes. This map unit occurs as gently sloping areas of Bates soil and Urban land, most of which are near Independence. The Bates soil is well drained. Individual areas are about 45 percent Bates soil and 40 percent Urban land. The Bates soil and Urban land occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the Bates soil has a surface layer of very dark brown loam about 7 inches thick. The subsoil is about 17 inches thick. The upper part is very dark grayish brown, friable loam, and the lower part is dark brown, firm clay loam. Interbedded soft sandstone and sandy and silty shale are at a depth of about 24 inches. In places the subsoil contains many sandstone fragments. In some areas the surface layer is silt loam. Some of the low areas have been filled or leveled, and other small areas have been cut or filled during construction.

The Urban land is covered by streets, parking lots, sidewalks, and buildings and other structures. The soils are so obscured or altered that identification is not possible.

Included with the Bates soil and the Urban land in mapping are small areas of Collinsville, Dennis, and Eram soils. The well drained, shallow Collinsville soils are in the steeper areas. The moderately well drained Dennis and Eram soils are on foot slopes. They have a clayey subsoil. Also included are areas where cutting and filling have so altered the Bates soil that identification is difficult. Included areas make up about 15 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. The surface layer is friable, and tilth is good. Root penetration is restricted below a depth of about 24 inches. In most unlimed areas the surface layer and subsoil are strongly acid to slightly acid.

The Bates soil is suited to grasses, flowers, vegetables, and shrubs if additional water is applied during periods of low rainfall. Because the root zone is only moderately deep, the soil is poorly suited to trees unless additional water is regularly applied during periods of low rainfall. Erosion is a serious hazard in areas that are bare during construction and in areas that are used as a watercourse. It can be controlled by establishing a plant cover or by applying mulch.

The Bates soil is suitable as a site for dwellings without basements and for local roads and streets. It is not suitable, however, as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. All sanitary facilities should be connected to commercial sewers and treatment facilities.

No capability subclass is assigned to this map unit.

Ca—Catoosa silt loam, 0 to 2 percent slopes. This nearly level, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 500 acres in size.

Typically, the surface layer is dark reddish brown silt loam about 10 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 21 inches thick. Hard limestone is at a depth of about 31 inches. In places the depth to hard limestone is more than 40 inches. In some small areas limestone is on the surface.

Included with this soil in mapping are small areas of Kenoma, Shidler, and Zaar soils. The deep, moderately well drained Kenoma soils are in the higher convex areas. They are grayer than the Catoosa soil. The shallow Shidler soils are on the steeper side slopes. The somewhat poorly drained Zaar soils are along drainageways. They have a clayey surface layer and subsoil. Also included are small areas where rock crops out. Included areas make up 5 to 15 percent of the map unit.

Permeability and available water capacity are moderate in the Catoosa soil. Surface runoff is medium. The surface layer is friable, and tilth is good. The shrink-swell potential is moderate. Root penetration is restricted below a depth of about 31 inches. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The depth to rock and the shrink-swell potential are moderate limitations if this soil is used as a site for dwellings without basements. Properly designing and reinforcing foundations helps to prevent the structural damage caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome this limitation.

This soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils are better sites for sewage lagoons.

The capability subclass is IIe.

Db—Dennis silt loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on side slopes and low knolls in the uplands. Individual areas are irregular in shape and range from 40 to 400 acres in size.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is very dark brown silt loam about 5 inches thick. The subsoil to a depth of about 60 inches is dark brown and is mottled. The upper part is friable silty clay loam, and the lower part is firm silty clay. In some areas the upper part of the subsoil is silty clay.

Included with this soil in mapping are small areas of Bates and Eram soils. The Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. The Eram soils are more clayey in the surface layer than the Dennis soil and are moderately deep over shale. They are on the upper side slopes. Also included are small areas of sodic soils or slick spots. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable, and tilth is good. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 2 to 3 feet. Reaction is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture (fig. 9) and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material

Figure 9.—Cattle grazing bermudagrass on Dennis silt loam, 1 to 4 percent slopes.

help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping areas are the better sites.

The capability subclass is IIe.

Dc—Dennis silt loam, 4 to 7 percent slopes. This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 150 acres in size.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsoil to a depth of about 60 inches is dark brown and is mottled. The upper part is friable silty clay loam, and the lower part is firm silty clay. In some areas the upper part of the subsoil is silty clay.

Included with this soil in mapping are small areas of Bates and Eram soils. The Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. The Eram soils are more clayey in the surface layer than the Dennis soil and are moderately deep over shale. They are on the upper side slopes. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The surface layer is friable, and tilth is good. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 2 to 3 feet. Reaction is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that control erosion, maintain tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping areas are the better sites.

The capability subclass is IIIe.

Eb—Eram silty clay loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 11 inches thick. The subsoil is firm silty clay about 21 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is grayish brown. Light olive brown shale is at a depth of about 32 inches (fig. 10). In places the surface layer is silt loam or silty clay. In some small areas the depth to shale is more than 40 inches.

Included with this soil in mapping are small areas of Bates and Talihina soils. The Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. The Talihina soils are less than 20 inches deep over shale. They are more sloping than the Eram soil and are on ridges and side slopes. Included soils make up 5 to 10 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable, and tilth is fair. The shrink-swell potential is high (fig. 11). The seasonal high water table is perched at a depth of 2 to 3 feet. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted below a depth of about 32 inches.

Most areas are cultivated. This soil is suited to soybeans, grain sorghum, corn, wheat, legumes, and tall fescue. Measures that control erosion, improve tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a

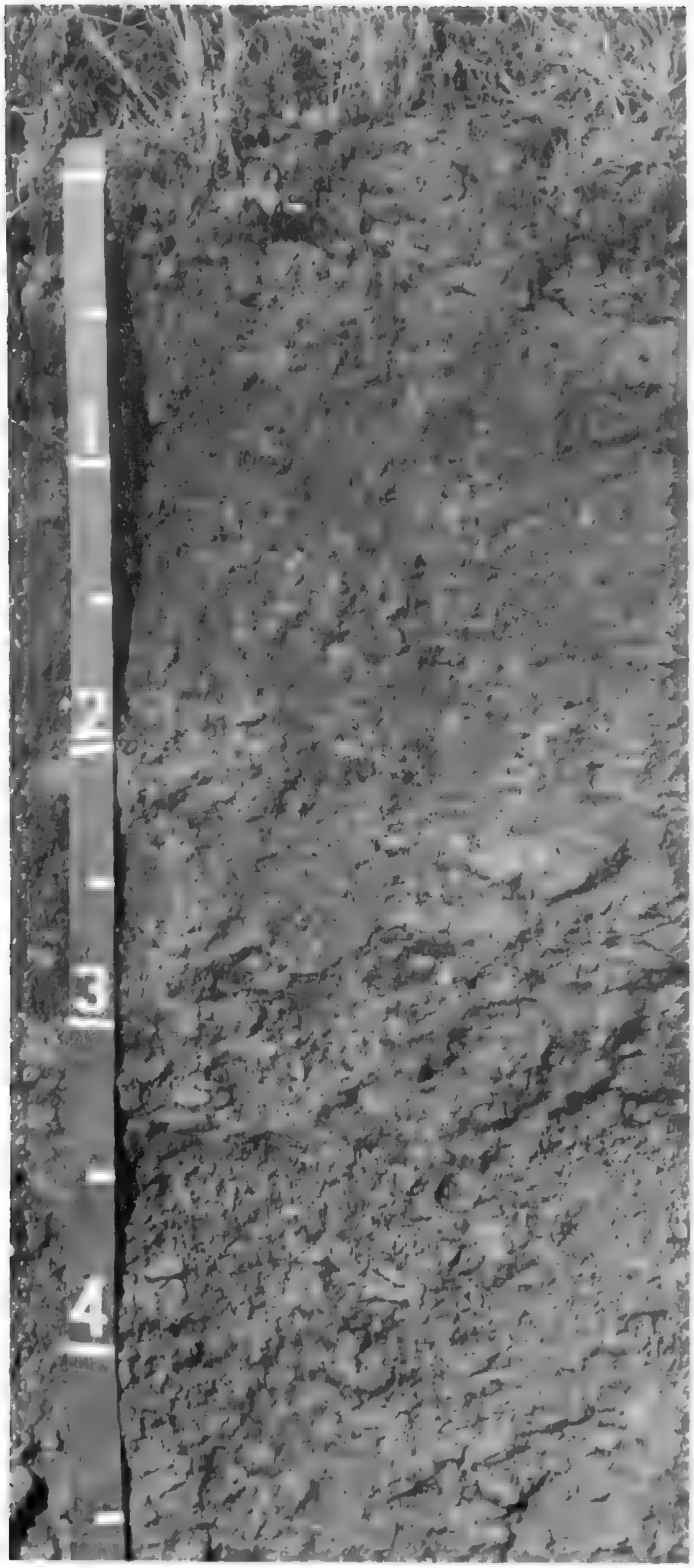

Figure 10.—Profile of Eram silty clay loam, 1 to 4 percent slopes. Soft shale is at a depth of about 32 inches. Depth is marked in feet.

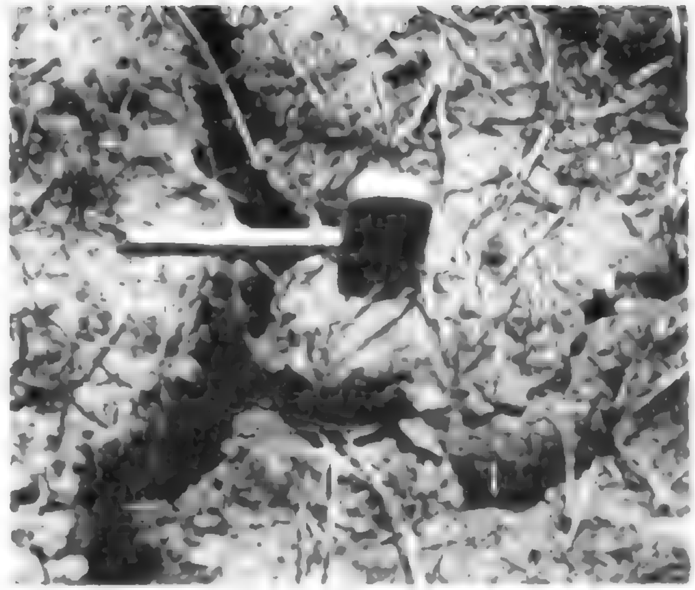

Figure 11.—Cracks caused by shrinking of Eram silty clay loam, 1 to 4 percent slopes.

severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability, the wetness, and the depth to rock are severe limitations. The depth to rock is a severe limitation on sites for sewage lagoons. The less sloping, deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is IIIe.

Ec—Eram silty clay loam, 2 to 6 percent slopes, eroded. This moderately sloping, moderately well drained soil is on the narrow tops and sides of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 100 acres in size.

Erosion has removed most of the original surface layer. Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is firm silty clay about 16 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. Soft shale is at a depth of about 24 inches. In places the surface layer is silty clay. In some small areas the depth to shale is more than 40 inches.

Included with this soil in mapping are small areas of Bates and Talihina soils. The Bates soils have a loamy subsoil and are moderately deep over sandstone. They

are on the upper side slopes. The Talihina soils are less than 20 inches deep over shale. They are more sloping than the Eram soil and are on ridges and side slopes. Included soils make up 5 to 10 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is firm, and tilth is poor. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 2 to 3 feet. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted below a depth of 24 inches.

About 50 percent of the acreage is cultivated. The rest is mainly pasture. This soil is suited to soybeans, grain sorghum, wheat, and tall fescue. The hazard of further erosion is severe if cultivated crops are grown. Improving tilth and increasing the content of organic matter are other concerns in managing cultivated areas. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour help to prevent excessive soil loss, improve tilth, and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pastures, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability, the wetness, and the depth to rock are severe limitations. The depth to rock is a severe limitation on sites for sewage lagoons. The less sloping, deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is IVe.

Ef—Eram silty clay loam, 4 to 7 percent slopes. This moderately sloping, moderately well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 250 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. The subsoil is firm silty clay about 22 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is grayish brown. Light olive brown shale is at a depth of about 30 inches. In places the surface layer is silt loam or silty clay. In some small areas the depth to shale is more than 40 inches.

Included with this soil in mapping are small areas of Bates and Talihina soils. The Bates soils have a loamy subsoil and are moderately deep over sandstone. They are on the upper side slopes. The Talihina soils are less than 20 inches deep over shale. They are more sloping than the Eram soil and are on ridges and side slopes. Also included are small areas that are severely eroded. Included soils make up 5 to 15 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable, and tilth is fair. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 2 to 3 feet. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Root penetration is restricted below a depth of 30 inches.

About half the areas are cultivated. The rest mainly are used as tame grass pasture. This soil is suited to soybeans, grain sorghum, wheat, legumes, and tall fescue. Measures that control erosion, improve tilth, and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing (fig. 12), and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability, the wetness, and the depth to rock are severe limitations. The depth to rock is a severe limitation on sites for

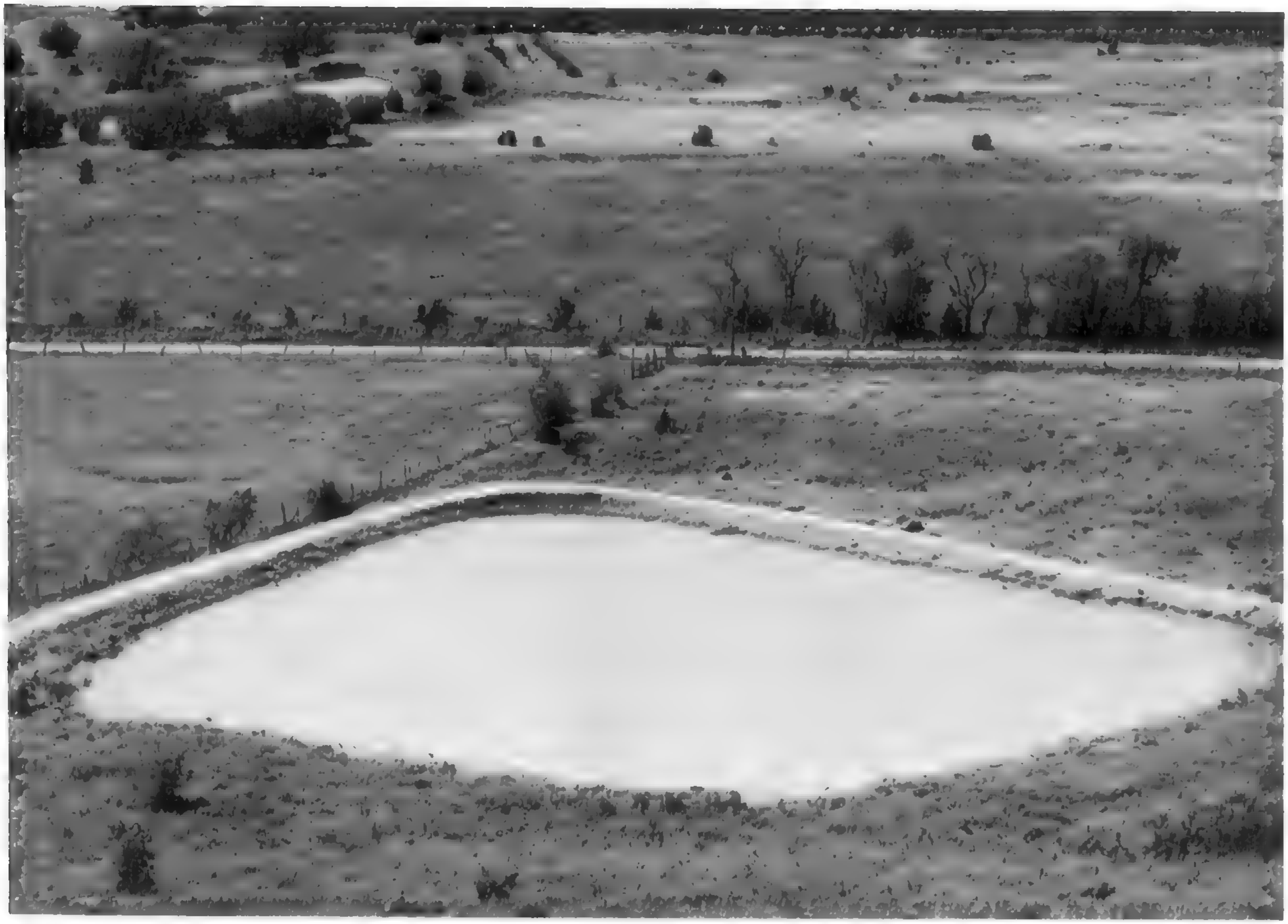

Figure 12.—Farm pond in an area of Eram silty clay loam, 4 to 7 percent slopes. Farm ponds help to distribute grazing.

sewage lagoons. The less sloping, deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is IVe.

Et—Eram-Talihina silty clay loams, 6 to 20 percent slopes. These moderately sloping to moderately steep, moderately well drained soils are on the tops and sides of ridges in the uplands. The Eram soil is less sloping than the Talihina soil. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 50 percent Eram soil and 35 percent Talihina soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Eram soil has a surface layer of very dark brown silty clay loam about 8 inches thick. The subsoil is firm silty clay about 19 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is grayish brown. Light olive brown shale is at a depth of about 27 inches. In places the surface layer is silt loam or silty clay. In some small areas the depth to shale is more than 40 inches.

Typically, the Talihina soil has a surface layer of very dark grayish brown silty clay loam about 7 inches thick. The subsoil is dark grayish brown, firm silty clay about 7 inches thick. The substratum is light olive brown, mottled silty clay that contains many shale fragments. Light olive brown, soft shale is at a depth of about 17 inches.

Included with these soils in mapping are small areas of Bates, Collinsville, and Dennis soils. The Bates soils have a loamy subsoil and are moderately deep over

sandstone. They are less sloping than the Eram and Talihina soils and are on side slopes. The Collinsville soils are sandier than the Eram and Talihina soils and are shallow over sandstone. They are on ridgetops. The deep Dennis soils are less clayey in the surface layer than the Eram and Talihina soils. They are on the lower side slopes. Also included are small areas of Shale outcrop on breaks and the steeper side slopes. Included areas make up about 15 percent of the map unit.

Permeability is slow in the Eram and Talihina soils, and available water capacity is low. Surface runoff is rapid. The shrink-swell potential is high. Reaction is slightly acid or medium acid throughout both soils. The seasonal high water table is perched at a depth of 2 or 3 feet in the Eram soil and at a depth of 0.5 to 2 feet in the Talihina soil. Root penetration is restricted below a depth of 27 inches in the Eram soil and 17 inches in the Talihina soil.

These soils generally are unsuitable for cultivation. Erosion is a severe hazard if cultivated crops are grown.

Most areas are used as native range. These soils are well suited to native range and tame grass pasture. The major concerns of management are undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The shrink-swell potential of the Eram soil, the depth to rock in the Talihina soil, and the wetness of both soils are severe limitations on sites for dwellings with basements. The deeper included soils are better suited than the Talihina soil. Properly designing and reinforcing foundations and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The shrink-swell potential of the Eram soil, the wetness of the Talihina soil, and the low strength of both soils are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

These soils generally are unsuitable as septic tank absorption fields because the depth to rock, the slow permeability, and the wetness are severe limitations. The depth to rock and the slope are severe limitations on sites for sewage lagoons. The less sloping, deeper adjacent soils are better sites.

The capability subclass is VIe.

Eu—Eram-Urban land complex, 2 to 6 percent slopes. This map unit occurs as moderately sloping areas of an Eram soil and Urban land, generally in and near Coffeyville. The Eram soil is moderately well drained. Individual areas are about 45 percent Eram soil and 35 percent Urban land. The Eram soil and Urban land occur as areas so intermingled or so small that mapping them separately is not feasible.

Typically, the Eram soil has a surface layer of very dark brown silty clay loam about 8 inches thick. The subsoil is firm silty clay about 22 inches thick. The upper part is very dark grayish brown, and the lower part is grayish brown. Soft shale is at a depth of about 30 inches. Some low areas have been filled or leveled, and other small areas have been cut or filled during construction.

The Urban land is covered by streets, parking lots, sidewalks, and buildings and other structures. The soils are so obscured or altered that identification is not possible.

Included with the Eram soil and Urban land in mapping are small areas of Bates, Dennis, and Talihina soils. The well drained Bates soils are on the higher parts of the landscape. They are underlain by sandstone bedrock within a depth of 40 inches. The well drained Dennis soils are on foot slopes. They are deep over shale. The Talihina soils are underlain by shale within a depth of 20 inches. They are on the steeper parts of the landscape. Also included are areas where cutting and filling have so altered the Eram soil that identification is difficult. Included soils make up about 20 percent of the map unit.

Permeability is slow in the Eram soil, and available water capacity is low. Surface runoff is medium. The surface layer is friable, and tilth is fair. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 2 to 3 feet. Root penetration is restricted below a depth of about 30 inches. In most unlimed areas the surface layer is slightly acid.

The Eram soil is suited to grasses, flowers, and shrubs if water is applied during periods of low rainfall. Because the root zone is only moderately deep, the soil is poorly suited to trees unless water is regularly applied during periods of low rainfall. Erosion is a serious hazard in areas that are bare during construction and in areas that are used as a watercourse. It can be controlled by establishing a plant cover and by applying mulch.

The shrink-swell potential of the Eram soil is a severe limitation on sites for dwellings. Also, the wetness is a severe limitation on sites for dwellings with basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The low strength and shrink-swell potential of the Eram soil are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or

replacing the base material help to overcome these limitations.

The depth to rock, the wetness, and the slow permeability are severe limitations if the Eram soil is used as a septic tank absorption field. All sanitary facilities should be connected to commercial sewers and treatment facilities.

No capability class or subclass is assigned to this map unit.

Ka—Kenoma silt loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on broad upland ridgetops. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsoil to a depth of about 60 inches is firm and very firm silty clay (fig. 13). The upper part is very dark grayish brown and dark yellowish brown and is mottled with strong brown, and the lower part is dark brown. In some areas the upper part of the subsoil is friable silty clay loam. In other areas the surface layer is silty clay loam. In places shale is within a depth of 40 inches.

Included with this soil in mapping are small areas of Catoosa and Zaar soils. The Catoosa soils are moderately deep over limestone. They are below the Kenoma soil on the landscape. The Zaar soils have a clayey surface layer. They are along drainageways. Also included are small areas of a sodic soil and slick spots. Included areas make up 5 to 15 percent of the map unit.

Permeability is very slow in the Kenoma soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. The shrink-swell potential is high. Reaction is slightly acid or neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. The silty clay subsoil fails to release water readily to plants, however, and crops are adversely affected during prolonged dry periods. Maintaining tilth and increasing the content of organic matter are concerns of management. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour help to control surface runoff, maintain tilth, and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

Figure 13.—Profile of Kenoma silt loam, 0 to 2 percent slopes. This soil has a claypan at a depth of about 12 inches. Depth is marked in feet.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the

structural damage caused by shrinking and swelling. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

Because the very slow permeability is a severe limitation, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

La—Lanton silty clay loam. This nearly level, somewhat poorly drained soil is on flood plains along streams. It is occasionally flooded for very brief periods. Individual areas are long and narrow or irregularly shaped and range from 40 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 12 inches thick. The subsurface layer is very dark gray, mottled, firm silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled silty clay loam and silty clay. In some areas the surface layer and subsurface layer are silt loam.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Lanton soil. They make up about 5 to 10 percent of the map unit.

Permeability is slow in the Lanton soil, and available water capacity is high. Surface runoff is slow. The surface layer is firm, and tilth is fair. The shrink-swell potential is moderate. The seasonal high water table is at a depth of 1 to 2 feet. Reaction ranges from slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. The main concern of management is the crop damage caused by wetness. Improving tilth and increasing the content of organic matter are other concerns. Drainage ditches reduce the wetness. Keeping tillage at a minimum and leaving crop residue on the surface improve tilth and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

This soil is well suited to trees. A few areas are native woodland (fig. 14). Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No hazards or limitations affect planting or harvesting.

This soil generally is unsuitable as a site for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets because the flooding is a severe hazard and the wetness is a severe limitation.

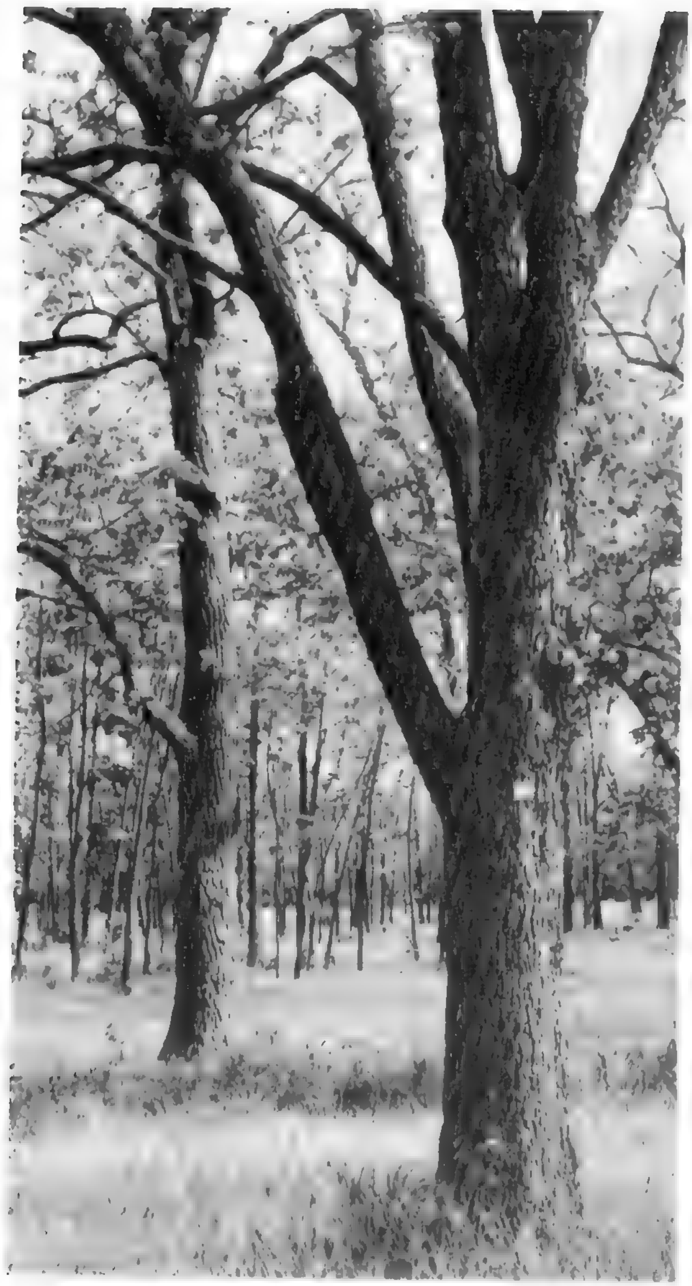

Figure 14.—A wooded area of Lanton silty clay loam.

Overcoming the flooding is difficult without major flood control measures.

The capability subclass is IIw.

Ma—Mason silt loam. This nearly level, well drained soil is on stream terraces. It is subject to rare flooding for very brief periods. Individual areas are long and narrow or irregularly shaped and range from 40 to 300 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is very dark brown, friable silt loam about 10 inches thick. The subsoil to a depth of more than 60 inches is friable silty clay loam. The upper part is very dark grayish brown, and the lower part is dark brown. In some areas the subsoil is silt loam or silty clay.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Mason soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderately slow in the Mason soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. The shrink-swell potential is moderate. Reaction is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that maintain tilth and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum and leaving crop residue on the surface.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

This soil is well suited to trees. A few areas are native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No hazards or limitations affect harvesting.

The flooding is a severe hazard if this soil is used as a site for dwellings. Dikes, levees, or similar structures can lessen this hazard. Low strength is a severe limitation on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome this limitation.

The moderately slow permeability is a severe limitation if this soil is used as a septic tank absorption field. Increasing the size of the absorption field helps to overcome this limitation. The soil is suitable as a site for sewage lagoons.

The capability class is I.

Nd—Niotaze-Darnell complex, 8 to 20 percent slopes. These strongly sloping to steep soils are on side slopes in the uplands. The somewhat poorly drained Niotaze soil is steeper than the Darnell soil and is on the lower side slopes. The well drained Darnell soil is on the upper side slopes. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 50 percent Niotaze soil and 35 percent Darnell soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Niotaze soil has a surface layer of dark brown cobbly fine sandy loam about 5 inches thick. The subsurface layer is brown, friable cobbly fine sandy loam about 6 inches thick. The subsoil is about 21 inches thick. The upper part is yellowish red, very firm silty clay, and the lower part is yellowish brown, mottled, firm silty clay loam. Silty shale is at a depth of about 32 inches.

Typically, the Darnell soil has a surface layer of dark brown fine sandy loam about 6 inches thick. The subsoil is brown, friable fine sandy loam about 10 inches thick. Sandstone is at a depth of about 16 inches. In some areas the depth to sandstone is more than 20 inches.

Included with these soils in mapping are small areas of the deep, moderately well drained Dennis soils on the lower side slopes. These included soils have a silt loam surface layer. Also included are small areas where sandstone crops out. Included areas make up about 15 percent of the map unit.

Permeability is slow in the Niotaze soil and moderately rapid in the Darnell soil. Available water capacity is low in both soils. Surface runoff is rapid. The shrink-swell potential is high in the Niotaze soil. This soil has a seasonal high water table that is perched at a depth of 1 to 2 feet. Both soils are slightly acid to strongly acid. Root penetration is restricted below a depth of 32 inches in the Niotaze soil and 16 inches in the Darnell soil.

Most areas occur as woodland that has an understory of shrubs and grasses. They are not productive as woodland and are used for grazing. Native grasses are interspersed with the trees. A small acreage has been cleared and supports tame grasses. The soils generally are unsuitable for cultivation because of the low available water capacity.

These soils are suited to native range and tame grass pasture. The major concerns of management are undesirable plants, the low available water capacity, erosion, and low forage production. If the pasture or range is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and conserves moisture. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as

tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

The shrink-swell potential and wetness of the Niotaze soil and the depth to rock in the Darnell soil are severe limitations on sites for dwellings with basements. The deeper included soils are better sites than the Darnell soil. Properly designing and reinforcing foundations and backfilling with porous material help to prevent the structural damage caused by the shrinking and swelling of the Niotaze soil. The shrink-swell potential and low strength of the Niotaze soil are severe limitations on sites for local roads and streets, and the depth to rock and slope of the Darnell soil are moderate limitations. The adverse effects of shrinking and swelling can be lessened by properly designing the roads or streets and by strengthening or replacing the base material.

The depth to rock in both soils is a severe limitation on sites for septic tank absorption fields and sewage lagoons. The less sloping, deeper included soils are better sites for sewage lagoons.

The capability subclass is VIIs.

Oa—Oil wasteland. This map unit consists of moderately deep or deep, excessively drained soils on ridgetops and side slopes. It is nearly level to moderately sloping. It occurs as areas that have been severely affected by oil, saltwater, or other waste from oil wells (fig. 15). Individual areas are irregular in shape and range from 5 to 20 acres in size.

The original soil in most of the areas cannot be identified. The surface layer is grayish brown silty clay, silt loam, or loam about 10 inches thick. It has a high

Figure 15.—A typical area of Oil wasteland.

content of sodium salts. The underlying material to a depth of more than 60 inches is firm silty clay. The upper part has a high content of sodium salts.

Permeability is very slow, and runoff is very rapid. Available water capacity is very low. The surface is hard and tends to crust during dry periods.

This map unit generally is unsuited to cultivated crops and grasses because of the high content of sodium salts. The plant cover is sparse, and many areas are eroded. Diverting the runoff from higher areas helps to control erosion.

The capability subclass is VIIs.

Od—Olpe-Dennis complex, 2 to 6 percent slopes. These moderately sloping soils are on uplands. The well drained Olpe soil generally is more sloping than the Dennis soil and is on the higher side slopes. The moderately well drained Dennis soil is on foot slopes. Individual areas are long and narrow or irregularly shaped and range from 20 to 200 acres in size. They are about 55 percent Olpe soil and 35 percent Dennis soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Olpe soil has a surface layer of dark brown gravelly silt loam about 16 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark reddish brown, firm very gravelly silty clay loam, and the lower part is dominantly reddish brown and yellowish red, very firm very gravelly silty clay. In some areas the subsoil is less clayey.

Typically, the Dennis soil has a surface layer of very dark brown silt loam about 9 inches thick. The subsoil to a depth of about 60 inches is dark brown. The upper part is friable silty clay loam, and the lower part is mottled, firm silty clay. In places the upper part of the subsoil is firm silty clay. In some areas the content of small pebbles is 5 to 10 percent throughout the soil.

Included with these soils in mapping are small areas of Bates soils on ridgetops. These included soils have a loam surface layer and are underlain by sandstone within a depth of 40 inches. Also included are small areas where limestone crops out on the lower side slopes. Included areas make up about 10 percent of the map unit.

Permeability is slow in the Olpe and Dennis soils, and surface runoff is medium. Available water capacity is moderate in the Olpe soil and high in the Dennis soil. The shrink-swell potential is moderate in the Olpe soil and high in the Dennis soil. The Dennis soil has a seasonal high water table that is perched at a depth of 2 to 3 feet. Both soils dominantly are slightly acid or neutral.

These soils generally are unsuitable for cultivation. The hazard of erosion is severe if cultivated crops are grown.

Most areas are used as native range. These soils are well suited to native range and tame grass pasture. The major concerns of management are undesirable plants and erosion. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The shrink-swell potential of the Olpe soil is a moderate limitation on sites for dwellings with basements, and the shrink-swell potential and wetness of the Dennis soil are severe limitations. Properly designing and reinforcing foundations and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The shrink-swell potential of the Olpe soil is a moderate limitation on sites for local roads and streets, and the shrink-swell potential and low strength of the Dennis soil are severe limitations. The adverse effects of the shrinking and swelling and low strength can be lessened by properly designing the roads or streets and by strengthening or replacing the base material.

These soils generally are unsuitable as septic tank absorption fields because the slow permeability of both soils and the wetness of the Dennis soil are severe limitations. The slope of both soils and seepage in the Olpe soil are moderate limitations on sites for sewage lagoons. Sealing the lagoon helps to control the seepage. Less sloping soils are better sites for sewage lagoons.

The capability subclass is VIe.

Or—Orthents, clayey. These soils occur as areas on uplands and bottom land where the upper 2 to 4 feet of the more fertile soil material has been removed and used as fill material on construction sites. Most of these areas are near the Elk City Reservoir. Some are frequently flooded or ponded. The soils generally are nearly level but are moderately sloping on short side slopes. Individual areas range from 10 to 100 acres in size.

This soil is variable, but the surface layer of one of the more common pedons is dark brown silty clay about 8 inches thick. The underlying material is dark yellowish brown and brown, firm silty clay. In some areas the surface layer and the upper part of the underlying material are silty clay loam.

Included with these soils in mapping are small areas where shale and limestone crop out.

Permeability and surface runoff are slow. The shrink-swell potential is high. The depth of the root zone varies.

Most areas are used for tame grass pasture. Some are idle. These soils generally are unsuited to cultivated crops because of ponding or flooding, poor tilth, and low fertility.

The major concerns in managing the pastured areas are control of undesirable plants and low forage production in abandoned areas. Overgrazing reduces the quality and quantity of the forage and increases the extent of less productive annual grasses, weeds, and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. Deferred grazing, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production. Reseeding abandoned areas also increases forage production.

The capability subclass is IVs.

Os—Osage silty clay. This nearly level, poorly drained soil is on flood plains. It is occasionally flooded. Individual areas are long and narrow or irregularly shaped and range from 40 to 400 acres in size.

Typically, the surface layer is very dark gray silty clay about 6 inches thick. The subsurface layer is black, very firm silty clay about 9 inches thick. The subsoil to a depth of about 60 inches is very dark gray, very firm and extremely firm silty clay.

Included with this soil in mapping are small areas of Lanton and Verdigris soils. These soils are slightly higher on the landscape than the Osage soil and are nearer the stream channel. The Lanton soils have a silty clay loam surface layer. The Verdigris soils have a silt loam surface layer and subsurface layer. Included soils make up 5 to 10 percent of the map unit.

Permeability is very slow in the Osage soil, and available water capacity is moderate. Surface runoff is very slow. The surface layer is very firm, and tilth is poor. The shrink-swell potential is very high. The seasonal high water table is perched within a depth of 1 foot. Reaction is slightly acid or neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are damaged, however, during some wet periods. Also, they are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Improving tilth and increasing the content of organic matter are concerns of management. Bedding and drainage ditches reduce the wetness. Keeping tillage at a minimum and leaving crop residue on the surface improve tilth and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

This soil is suited to trees. A few areas are native woodland. The equipment limitation is moderate, and seedling mortality and plant competition are severe. Because of the wetness, the use of equipment is limited to dry periods. Tree seeds, cuttings, and seedlings survive and grow well only if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIIw.

Pa—Parsons silt loam. This nearly level, somewhat poorly drained soil is on uplands. Individual areas are irregular in shape and range from 40 to 500 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. It has an abrupt lower boundary. The subsoil is very firm silty clay about 40 inches thick. The upper part is very dark grayish brown and is mottled with reddish brown, and the lower part is grayish brown and gray and is mottled with brown and light gray. The substratum to a depth of about 60 inches is mottled gray, reddish yellow, and yellowish red silty clay. In some areas the subsurface layer is darker.

Included with this soil in mapping are small areas of Zaar soils along drainageways. These soils have a clayey surface layer. They make up about 5 to 10 percent of the map unit.

Permeability is very slow in the Parsons soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 0.5 to 1.5 feet. Reaction is slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Crop yields are adversely affected during dry periods, however, because the clayey subsoil fails to release water readily to plants. Also, they are damaged during some wet periods. Maintaining tilth and increasing the content of organic matter are concerns of management. Keeping tillage at a minimum and leaving crop residue on the surface help to maintain tilth and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of

fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength, wetness, and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

Qu—Quarries. This map unit consists of areas from which soil and some underlying limestone or shale have been removed. The underlying material has been quarried for use as gravel and for use in the manufacturing of cement, brick, and agricultural lime. Individual areas are irregular in shape and range from 20 to 350 acres in size.

A typical quarry is a pit surrounded by vertical walls 8 to 20 feet high. Small piles of rock, shale, and gravel are around the outer edge of some quarries.

This map unit is unsuitable for cultivation and for most other uses. The surface generally is bare. Scattered trees, shrubs, and clumps of grass border the quarries.

No capability class or subclass is assigned to this map unit.

Sc—Shidler-Catoosa silt loams, 1 to 4 percent slopes. These gently sloping, well drained soils are on uplands. The Shidler soil is on side slopes and along drainageways, and the Catoosa soil is on ridgetops. Individual areas are long and narrow or irregularly shaped and range from 20 to 300 acres in size. They are about 45 percent Shidler soil and 40 percent Catoosa soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Shidler soil has a surface layer of very dark gray silt loam about 11 inches thick. This layer contains limestone fragments. Hard limestone is at a depth of about 11 inches.

Typically, the Catoosa soil has a surface layer of dark reddish brown silt loam about 10 inches thick. The subsoil is dark reddish brown, firm silty clay loam about 21 inches thick. Hard limestone is at a depth of about 31 inches. In places the depth to bedrock is more than 40 inches. In some areas limestone is throughout the soil.

Included with these soils in mapping are small areas of Talihina soils. These soils have a silty clay loam surface layer and are underlain by shale. They are in areas where shale crops out between ledges of limestone. Also included are small areas where limestone crops out. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Shidler and Catoosa soils, and surface runoff is medium. Available water capacity is low in the Shidler soil and moderate in the Catoosa soil. The shrink-swell potential is moderate in the Catoosa soil. Root penetration is restricted at a depth of about 11 inches in the Shidler soil and 31 inches in the Catoosa soil. Reaction is slightly acid or neutral in the surface layer of the Shidler soil. It is slightly acid or medium acid in the surface layer of the Catoosa soil and ranges from strongly acid to neutral in the subsoil.

These soils generally are unsuitable for cultivation. The depth to bedrock is a limitation, and erosion is a hazard.

Most areas are used as native range. These soils are well suited to native range and moderately well suited to tame grass pasture. The major concerns of management are undesirable plants and erosion. If the pasture or range is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The depth to rock is a severe limitation if these soils are used as sites for dwellings with basements. The deeper adjacent soils are better sites. The depth to rock in the Shidler soil and low strength in the Catoosa soil are severe limitations on sites for local roads and streets. Low strength can be overcome by properly designing the roads or streets and by strengthening or replacing the base material.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The less sloping, deeper adjacent soils are better sites for sewage lagoons.

The capability subclass is VIe.

Sd—Stephenville-Darnell fine sandy loams, 1 to 5 percent slopes. These gently sloping, well drained soils are on the tops of ridges in the uplands. The Stephenville soil is less sloping than the Darnell soil and is higher on the landscape. Individual areas are irregular in shape and range from 50 to 200 acres in size. They are about 50 percent Stephenville soil and 40 percent Darnell soil. The two soils occur as areas so intermingled that mapping them separately is not practical.

Typically, the Stephenville soil has a surface layer of very dark grayish brown fine sandy loam about 7 inches thick. The subsurface layer is brown fine sandy loam about 10 inches thick. The subsoil is yellowish red, friable sandy clay loam about 13 inches thick. Soft sandstone is at a depth of about 30 inches (fig. 16).

Typically, the Darnell soil has a surface layer of dark brown fine sandy loam about 6 inches thick. The subsoil is brown, friable fine sandy loam about 10 inches thick. Soft sandstone is at a depth of about 16 inches. In some areas the depth to sandstone is less than 10 inches.

Included with these soils in mapping are small areas of the deep Dennis and moderately deep Niotaze soils. These included soils have a clayey subsoil. The Dennis soils are on the higher parts of the landscape, and the Niotaze soils are on the steeper side slopes. Also included are small areas where sandstone crops out. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Stephenville soil and moderately rapid in the Darnell soil. Available water capacity is moderate in the Stephenville soil and low in the Darnell soil. Surface runoff is medium on both soils. Root penetration is restricted below a depth of about 30 inches in the Stephenville soil and 16 inches in the Darnell soil. Both soils are slightly acid to strongly acid throughout.

Most areas occur as woodland that has an understory of shrubs and grasses. They are not productive as woodland and are used for grazing. Native grasses are interspersed with the trees. A small acreage has been cleared and supports tame grasses.

These soils are suited to native range and tame grass pasture. The major concerns of management are undesirable plants and erosion. If the pasture or range is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover reduces the runoff rate and helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production.

Forage production is low on abandoned cropland. It can be increased by seeding desirable mid and tall grasses.

The Stephenville soil is suitable as a site for dwellings without basements and for local roads and streets. The Darnell soil is more poorly suited, however, because the depth to rock is a moderate limitation. Both soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The less sloping, deeper included or adjacent soils are better sites for sewage lagoons.

The capability subclass is IVe.

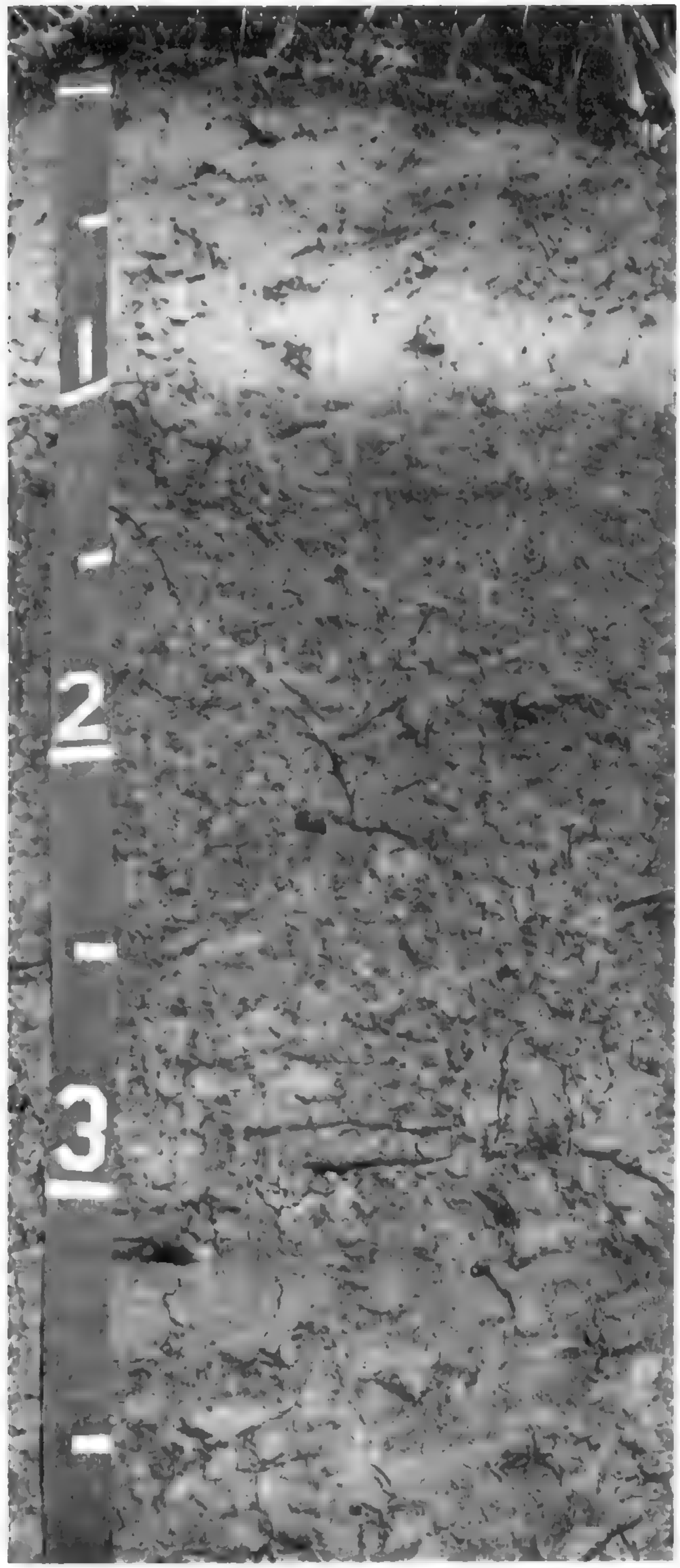

Figure 16.—Profile of Stephenville fine sandy loam. This soil formed in material weathered from sandstone. Depth is marked in feet.

Ts—Talihina-Shale outcrop complex, 10 to 50 percent slopes. This map unit occurs as strongly sloping to very steep areas of a Talihina soil and Shale outcrop on side slopes, escarpments, and ridgetops in the uplands. The Talihina soil is less steep than the Shale outcrop. It is moderately well drained. Individual areas are long and narrow or irregularly shaped and range from 40 to 200 acres in size. They are about 55 percent Talihina soil and 30 percent Shale outcrop. The Talihina soil and Shale outcrop occur as areas so intermingled that mapping them separately is not practical.

Typically, the Talihina soil has a surface layer of very dark grayish brown silty clay loam about 7 inches thick. The subsoil is dark grayish brown, firm silty clay about 7 inches thick. The substratum is light olive brown silty clay that contains common shale fragments. Light olive brown soft shale is at a depth of about 17 inches.

The Shale outcrop generally is exposed but in some areas is covered with less than 10 inches of soil material. This soil material is olive brown silty clay that contains many shale fragments.

Included with the Talihina soil and Shale outcrop in mapping are small areas of Collinsville, Eram, and Shidler soils. The Collinsville soils have a fine sandy loam surface layer and are underlain by sandstone. They are on the upper side slopes. The moderately deep Eram soils are less sloping than the Talihina soil and Shale outcrop and are on side slopes. The Shidler soils have a silt loam surface layer and are underlain by limestone. They are on ridgetops. Also included are small areas where limestone crops out on ridgetops. Included areas make up about 15 percent of the map unit.

Permeability is slow in the Talihina soil, available water capacity is low, and surface runoff is rapid. The shrink-swell potential is high. This soil has a seasonal high water table that is perched at a depth of 0.5 to 2 feet. It is neutral to medium acid throughout. Root penetration is restricted below a depth of about 17 inches.

Most areas are used as native range. This map unit generally is unsuitable for cultivation because of a severe hazard of erosion and the limited depth to shale. It is suited to native range. The major concerns in managing range are undesirable plants and erosion. If the range is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. After continued heavy grazing, the plant community is annual grasses, shrubs, and trees. An adequate plant cover helps to prevent excessive soil loss. Proper stocking rates, a uniform distribution of grazing, and brush control help to keep the range in good condition.

This map unit generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the slope is a severe limitation. The better suited included or adjacent soils should be selected as sites for those uses.

The capability subclass is VIIe.

Vb—Verdigris silt loam. This nearly level, moderately well drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are long and narrow or irregularly shaped and range from 4 to 400 acres in size.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is very dark brown, friable silt loam about 21 inches thick. The next 18 inches is dark brown, friable silt loam. The substratum to a depth of about 60 inches is brown silt loam. In some areas the surface layer or subsurface layer is silty clay loam.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Verdigris soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. The shrink-swell potential is moderate. Reaction is slightly acid or neutral in the subsurface layer and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Measures that maintain tilth and increase the content of organic matter are the main management needs. Examples are keeping tillage at a minimum and leaving crop residue on the surface.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

This soil is well suited to trees. A few areas are native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No hazards or limitations affect planting or harvesting.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Vc—Verdigris silt loam, channeled. This nearly level, moderately well drained soil is on narrow flood plains that are dissected by drainageways and meandering stream channels. It is frequently flooded for very brief

periods. Individual areas are long and about 200 feet to 500 feet wide and range from 10 to 60 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsurface layer is very dark brown, friable silt loam about 20 inches thick. The next 18 inches is dark brown, friable silt loam. The substratum to a depth of about 60 inches is brown silt loam. In some areas the surface layer or subsurface layer is silty clay loam.

Included with this soil in mapping are small areas of Osage soils. These soils have a silty clay surface layer and subsoil. They are in swales and other concave areas and are wet for longer periods than the Verdigris soil. They make up about 5 to 10 percent of the map unit.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The shrink-swell potential is moderate. Reaction is slightly acid or neutral throughout the soil.

Most areas are used as native range. This soil generally is unsuitable for cultivation because it is subject to flooding. It is well suited to native range and tame grass pasture. The major concerns in managing range or pasture are undesirable plants and flooding. If the range or pasture is overgrazed, the more desirable grasses and forbs are replaced by less productive mid and short grasses and by weeds and brush. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, a timely season of use, and brush control increase forage production. Reseeding cleared areas with mid or tall grasses also increases forage production.

This soil is well suited to trees. A few areas are native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Site preparation, controlled burning, spraying, and cutting or girdling control plant competition. No hazards or limitations affect planting or harvesting.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is Vw.

Wo—Woodson silt loam. This nearly level, somewhat poorly drained soil occurs as broad areas on uplands. Individual areas are irregular in shape and range from 40 to 500 acres in size.

Typically, the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is black, friable silt loam about 5 inches thick. The subsoil is very firm silty clay about 35 inches thick. The upper part is very dark gray, the next part is dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is dark gray, mottled silty clay. In some areas the surface layer is lighter colored and the upper part of the subsoil is more brown.

Included with this soil in mapping are small areas of Zaar soils along drainageways. These soils have a clayey surface layer. They make up about 10 percent of the map unit.

Permeability is very slow in the Woodson soil, and available water capacity is high. Surface runoff is slow. The surface layer is friable, and tilth is good. The shrink-swell potential is high. The seasonal high water table is perched at a depth of 0.5 to 2 feet. Reaction is medium acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are adversely affected during dry periods, however, because the clayey subsoil fails to release water readily to plants. Also, they are damaged during some wet periods. Measures that maintain tilth and increase the content of organic matter are needed. Examples are keeping tillage at a minimum and leaving crop residue on the surface.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength, the shrink-swell potential, and wetness are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

Za—Zaar silty clay, 0 to 1 percent slopes. This nearly level, somewhat poorly drained soil is on foot slopes in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 300 acres in size.

Typically, the surface layer is black silty clay about 6 inches thick. The subsurface layer is black, firm silty clay about 9 inches thick. The subsoil is mottled, firm and very firm silty clay about 35 inches thick. The upper part is very dark grayish brown, the next part is dark grayish

brown, and the lower part is olive brown. The substratum to a depth of about 60 inches is mixed olive brown and dark yellowish brown silty clay. In places the surface layer is silty clay loam. In some areas shale is within a depth of 40 inches.

Included with this soil in mapping are small areas of Verdigris and Woodson soils. The silty Verdigris soils are on narrow flood plains that are channeled. The Woodson soils have a silt loam surface layer. They are on broad ridgetops. Included soils make up 5 to 15 percent of the map unit.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is slow. The surface layer is firm, and tilth is fair. The shrink-swell potential is high. Cracks are common during dry periods. The seasonal high water table is perched at a depth of 1 to 2 feet. Reaction is medium acid or slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Crops are damaged, however, during some wet periods. Also, they are adversely affected during dry periods because the clayey subsoil fails to release water readily to plants. Surface bedding and drainage ditches reduce the wetness. Measures that improve tilth and increase the content of organic matter are needed. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour help to prevent excessive soil loss, improve tilth, and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIIw.

Zb—Zaar silty clay, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is on foot slopes and along drainageways in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 500 acres in size.

Typically, the surface layer is black silty clay about 6 inches thick. The subsurface layer is black, firm silty clay about 8 inches thick. The subsoil is mottled, firm and very firm silty clay about 35 inches thick. The upper part is very dark grayish brown, the next part is dark grayish brown, and the lower part is olive brown. The substratum to a depth of about 60 inches is mixed olive brown and dark yellowish brown silty clay. In places the surface layer is silty clay loam. In some areas shale is within a depth of 40 inches.

Included with this soil in mapping are small areas of Catoosa, Shidler, Verdigris, and Woodson soils. The well drained Catoosa and Shidler soils are on the lower side slopes near the drainageways. They are less than 40 inches deep over limestone bedrock. The silty Verdigris soils are on narrow flood plains that are channeled. The Woodson soils have a silt loam surface layer. They are on broad ridgetops. Included soils make up 5 to 15 percent of the map unit.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is medium. The surface layer is firm, and tilth is fair. The shrink-swell potential is high. Cracks are common during prolonged dry periods. The seasonal high water table is perched at a depth of 1 to 2 feet. Reaction is neutral or slightly acid in the subsoil and varies widely in the surface layer as a result of local liming practices.

Most areas are cultivated. This soil is suited to legumes, soybeans, grain sorghum, corn, wheat, and tall fescue. Erosion is a hazard, however, if cultivated crops are grown. Crops are damaged during prolonged wet periods. Also, they are adversely affected during prolonged dry periods because the clayey subsoil fails to release water readily to plants. Measures that improve tilth and increase the content of organic matter are needed. Keeping tillage at a minimum, leaving crop residue on the surface, establishing grassed waterways, terracing, and farming on the contour help to prevent excessive soil loss, improve tilth, and increase the content of organic matter.

This soil is well suited to tame grass pasture and native range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition. In the areas used as tame grass pasture, applications of fertilizer, proper stocking rates, rotation grazing, and a timely season of use increase forage production.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings.

Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Properly designing the roads or streets and strengthening or replacing the base material help to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the very slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. Less sloping areas are better sites.

The capability subclass is IIIe.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, and trees and shrubs.

crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

crops

About 40 percent of the acreage in Montgomery County was used for crops during 1975 and 1976. Wheat was grown on 41 percent of the cropped acreage, sorghum on 21 percent, hay on 17 percent, and soybeans, corn, alfalfa, oats, and barley on 21 percent.

During the period 1966 through 1976, the acreage planted to sorghum increased by 47 percent, that planted to soybeans by 11 percent, and that planted to wheat by 6 percent. The acreage planted to oats, barley, rye, and corn decreased considerably during this period.

Soil erosion is a problem on about 65 percent of the cropland in the county. If the slope is more than 1 percent, erosion is a hazard. It reduces the fertility of soils and results in sedimentation in streams. Fertility is reduced as the surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as, Kenoma, Dennis, and Woodson soils. Measures that control erosion improve fertility and minimize the pollution of streams by sediment.

A protective plant cover helps to control erosion by reducing the runoff rate. It also increases the infiltration rate. A cropping system that keeps a plant cover on the surface for extended periods not only helps to control erosion but also preserves the fertility of the soils.

Terraces and diversions reduce the length of slopes, the runoff rate, and the risk of erosion. They are most practical on deep, well drained soils that have uniform, regular slopes.

Contour farming should generally be used in combination with terraces. It is best suited to those soils that have smooth, uniform slopes and are suitable for terracing.

Leaving crop residue on the surface, either through minimum tillage or stubble mulching, increases the infiltration rate and reduces the runoff rate and the hazard of erosion. Minimum tillage and stubble mulching are becoming more common in Montgomery County.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Most of the soils used for crops have a silt loam surface layer that is moderately dark and moderate to low in content of organic matter. Generally, the soil structure is weak and intense rainfall reduces the infiltration rate and increases the runoff rate. Regularly adding a large amount of crop residue or leaving part of the residue on the surface improves soil structure and helps to prevent surface crusting and excessive erosion. Minimum tillage improves tilth and helps to control erosion in cultivated areas of the more sloping soils.

Soil drainage is a management need on some soils on flood plains. Unless drained by a system of surface drains or surface bedding, the somewhat poorly drained Lanton and poorly drained Osage soils, for example, are so wet that fertility is reduced.

Information about the design of erosion control practices is available in local offices of the Soil Conservation Service. The latest information about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

pasture

About 15 percent of the acreage in Montgomery County supports cool-season tame grasses, such as tall fescue. This acreage is throughout the county. Some areas support only tame grasses, and others support tame and native grasses.

The main concerns in managing pasture are maintaining or improving the quality and quantity of forage, providing protection against erosion, and reducing water loss.

Proper stocking rates help to keep the pasture in good condition. The number of livestock should be adjusted to the expected yield. Generally, about 40 pounds of forage per mature cow per day is needed for continuous seasonal grazing and 35 pounds for rotation grazing. Adjusting the number of livestock allows the pasture to provide forage for the entire grazing season.

Delaying grazing in the spring until the soil is dry and firm helps to prevent the surface compaction caused by trampling. Grazing should be deferred during the midsummer dormancy of tall fescue. Rotation grazing helps to prevent depletion of the pasture by allowing the grasses to recover after the pasture has been grazed. Providing water and salt at a variety of locations results in a uniform distribution of grazing.

Applying fertilizer helps to keep the pasture in good condition. The kind and amount should be based on the results of soil tests and on field observations. Mowing a pasture that has been grazed unevenly or has an excess of forage and spraying with herbicides control invading trees, brush, low quality grass, and broad-leaved weeds.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Leonard J. Jurgens, range conservationist, Soil Conservation Service, helped prepare this section.

About 35 percent of the acreage in Montgomery County is rangeland. The woodland that has an understory of grass also is used for grazing. Most of the rangeland is grazed by cattle. Cow-calf enterprises dominate, but rangeland also provides a major part of the forage for a number of stocker-feeder and yearling enterprises. Grasses on about 15,000 acres of pasture and some crop aftermath and wheat pasture supplement the forage grown on rangeland.

Nearly all of the soils in the county have an excellent potential for growing a high percentage of quality forage plants grazed by livestock and by rangeland wildlife.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for many soils in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition,* the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of the extent of undesirable brush species, conservation of water, and control of erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The rangeland in Montgomery County generally can be managed so that it is in excellent condition. In many areas only proper grazing use, deferred grazing, and occasional applications of approved herbicides or prescribed burning are needed. In some areas measures that remove or control dense stands of brush are needed. These measures can help to restore the potential natural plant community only if the grazing also is properly managed. On less than 5 percent of the rangeland, revegetation by seeding of the proper native species is needed. On the rest of the rangeland that is not in excellent condition, proper grazing use, deferred grazing, prescribed burning, and brush control are needed.

woodland management and productivity

About 10 percent of the acreage in Montgomery County is woodland. Most of the woodland is classified as noncommercial. Most is in the uplands in the western part of the county and in other upland areas throughout the county. The rest occurs as small, irregularly shaped tracts along streams. Nearly all of the woodland is grazed by livestock. Wooded areas also provide food and cover for wildlife. Some are used as recreation areas.

The principal native trees in the uplands are blackjack oak, post oak, hackberry, and ash. Other native trees, commonly along streams, are bur oak, red oak, white oak, pin oak, sycamore, maple, black walnut, pecan, hickory, and elm. Many of these trees are cut for saw logs when they reach adequate size. Some are cut for fuel or for fenceposts. Osageorange is planted in hedgerows and fence rows throughout the county. It is cut for fenceposts. Osageorange and redcedar grow extensively on overgrazed range.

The soils on bottom land have good potential for the trees used for sawtimber, but most of these soils are used for small grain, row crops, and alfalfa. The soils on uplands have poor potential for the trees used for sawtimber and fair potential for the trees used for fuel. The trees on the hilly uplands protect watersheds against erosion.

Nuts are harvested from pecan and walnut trees on a small acreage. In a few areas they are harvested from groves of pecan that have been cleared of undesirable competing trees.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of

a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants generally are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition. The species should be selected according to their suitability for the different kinds of soil. Measures that control grasses and weeds increase the amount of moisture that is available to the trees and shrubs. When the trees are young, protection from fire and from insects, rabbits, and rodents is needed.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Montgomery County has several areas of scenic and historic interest. Several watershed lakes, farm ponds, and the Elk and Verdigris Rivers provide opportunities for recreation. Montgomery State Fishing Lake and the areas around the Elk City Reservoir that are open to the public provide opportunities for camping, hunting, fishing, boating, picnicking, and sightseeing. Many other areas could be developed as recreation areas.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The

best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Montgomery County are bobwhite quail, mourning dove, prairie chicken, cottontail, fox squirrel, whitetail deer, and several species of waterfowl. Furbearers are common along the Elk and Verdigris Rivers and their tributaries. They are trapped on a limited basis.

Nongame species are numerous because the habitat types are diverse. Cropland, woodland, and grassland are interspersed throughout the county. Each of these habitat types provides a habitat for a different group of species.

Elk City Reservoir, Montgomery State Fishing Lake, and numerous ponds and streams provide good to excellent fishing. The species commonly caught in these waters are bass, bluegill, crappie, channel cat, bullhead, and flathead catfish.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants. The plants should be those that the soils can support and should be evenly distributed.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, wheat, oats, barley, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestems, switchgrass, indiangrass, goldenrod, ragweed, wheatgrass, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, cottonwood, black walnut, hackberry, willow, green ash, hickory, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, winterberry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are redcedar, pine, and spruce.

Shrubs are bushy woody plants that produce fruit, seeds, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, hawks, thrushes, woodpeckers, squirrels, opossum, raccoon, and whitetail deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwing blackbirds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyotes, jackrabbits, hawks, dickcissels, killdeer, and meadowlarks.

Onsite technical assistance in planning wildlife areas and in determining suitable species of vegetation for planting can be obtained from local offices of the Soil Conservation Service, the Kansas Fish and Game Commission, and the Cooperative Extension Service.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

sanitary facilities

Table 12 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1

or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Further information about sanitary facilities is available in *Using Soils of Kansas for Waste Disposal* (*4*).

construction materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction.

Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely

affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 18.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 to 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SC.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 18.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on

the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 18 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series. The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 66; Unified classification—D 2487 66T (ASTM); Mechanical analysis—T 88 72 (AASHTO); Liquid limit—T 89 68 (AASHTO); Plasticity index—T 90 70 (AASHTO); and Moisture density, Method A—T 99 74 (AASHTO).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*6*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 19, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, thermic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*5*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*6*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from thinly bedded sandstone and interbedded sandy and silty shale. Slope ranges from 1 to 6 percent.

Bates soils are similar to Catoosa and Stephenville soils and are commonly adjacent to Collinsville, Dennis, and Eram soils. Catoosa soils are moderately deep over limestone. Stephenville soils have an A2 horizon, do not have a mollic epipedon, and have low base saturation. Catoosa and Stephenville soils are on ridgetops. Collinsville soils are on the steeper side slopes. Their

solum is thinner than that of the Bates soils. Dennis and Eram soils have a subsoil that is more clayey than that of the Bates soils. Their positions on the landscape are similar to those of the Bates soils.

Typical pedon of Bates loam, 1 to 3 percent slopes, 1,200 feet west and 150 feet north of the southeast corner of sec. 36, T. 31 S., R. 15 E.

A1—0 to 9 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

B1—9 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; common fine roots; medium acid; gradual smooth boundary.

B2t—15 to 21 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and fine subangular blocky structure; hard, firm; common fine roots; thin clay films on faces of peds; about 10 percent small soft sandstone fragments, by volume; strongly acid; gradual smooth boundary.

B3—21 to 27 inches; dark brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few small black concretions; about 15 percent sandstone and shale fragments, by volume; strongly acid; clear wavy boundary.

Cr—27 inches; soft sandstone interbedded with sandy and silty shale.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 24 inches in thickness. Scattered sandstone fragments are throughout some pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly loam, but in some pedons it is silt loam or fine sandy loam. It is medium acid or slightly acid unless it is limed.

The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 5. It is clay loam or loam that ranges from 18 to 35 percent clay. It is strongly acid to slightly acid.

Catoosa series

The Catoosa series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope is 0 to 2 percent.

Catoosa soils are similar to Bates and Dennis soils and are commonly adjacent to Kenoma soils. Bates soils are moderately deep over sandstone. They are on narrow ridgetops. Dennis soils have a seasonal high water table and a solum that is thicker than that of the Catoosa soils. They are on the lower side slopes. Kenoma soils are on broad ridgetops. Their subsoil is more clayey than that of the Catoosa soils, and their solum is thicker.

Typical pedon of Catoosa silt loam, 0 to 2 percent slopes, 2,000 feet south and 100 feet west of the northeast corner of sec. 1, T. 31 S., R. 14 E.

A1—0 to 10 inches; dark reddish brown (5YR 2/2) silt loam, dark reddish brown (5YR 3/2) dry; moderate medium and fine granular structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.

B1—10 to 15 inches; dark reddish brown (5YR 3/2) silty clay loam, reddish brown (5YR 4/3) dry; moderate medium and fine granular structure; hard, firm; common fine roots; medium acid; gradual smooth boundary.

B2t—15 to 31 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) dry; moderate medium and fine subangular blocky structure; very hard, firm; common fine roots; few fine black concretions; strongly acid; abrupt wavy boundary.

R—31 inches; limestone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The mollic epipedon ranges from 10 to 20 inches in thickness. In some pedons limestone fragments are throughout the solum.

The A horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is slightly acid or neutral.

The B2t horizon has hue of 5YR or 2.5YR, value of 3 or 4 (moist or dry), and chroma of 3 or 4. It ranges from strongly acid to neutral.

Collinsville series

The Collinsville series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 1 to 20 percent.

Collinsville soils are similar to Darnell and Shidler soils and are commonly adjacent to Bates and Dennis soils. Darnell soils lack a mollic epipedon. They are on ridgetops. Shidler soils also are on ridgetops. They are shallow over limestone. Bates and Dennis soils are more than 20 inches deep over bedrock and have a subsoil. They generally are less sloping than the Collinsville soils and are higher or lower on the landscape.

Typical pedon of Collinsville fine sandy loam, in an area of Bates-Collinsville complex, 4 to 20 percent slopes, 300 feet east and 100 feet north of the southwest corner of sec. 19, T. 33 S., R. 16 E.

A1—0 to 11 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry;

moderate medium and fine granular structure; slightly hard, friable; many fine roots; strongly acid; gradual wavy boundary.

C—11 to 17 inches; dark yellowish brown (10YR 4/4) fine sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable; many fine roots; about 40 percent, by volume, sandstone fragments 1/4 inch to 3 inches in diameter; strongly acid; gradual wavy boundary.

R—17 inches; sandstone.

The thickness of the solum and the depth to sandstone range from 4 to 20 inches. The mollic epipedon is 7 to 12 inches thick. Reaction is slightly acid to strongly acid throughout the profile. In some areas fragments of sandstone are on the surface or are throughout the solum.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly fine sandy loam, but the range includes loam. The C horizon has hue of 10YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 or 4.

Darnell series

The Darnell series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 1 to 15 percent.

Darnell soils are similar to Collinsville and Stephenville soils and are commonly adjacent to Niotaze and Stephenville soils. Collinsville soils have a surface layer that is darker than that of the Darnell soils and lack a subsoil. In some areas they are more sloping than the Darnell soils. Stephenville soils are moderately deep over sandstone. They are on slopes above the Darnell soils. Niotaze soils are underlain by shale. They are on slopes below the Darnell soils.

Typical pedon of Darnell fine sandy loam, in an area of Stephenville-Darnell fine sandy loams, 1 to 5 percent slopes, 2,600 feet north and 100 feet east of the southwest corner of sec. 24, T. 32 S., R. 13 E.

A1—0 to 6 inches; dark brown (7.5YR 4/4) fine sandy loam, brown (7.5YR 5/4) dry; moderate medium granular structure; slightly hard, friable; common fine and medium roots; strongly acid; gradual smooth boundary.

B2—6 to 16 inches; brown (7.5YR 5/4) fine sandy loam, strong brown (7.5YR 5/6) dry; moderate medium granular structure; slightly hard, friable; common fine and medium roots; about 5 percent, by volume, sandstone fragments less than 1 inch in diameter; strongly acid; gradual wavy boundary.

Cr—16 inches; sandstone.

The thickness of the solum, or the depth to sandstone bedrock, ranges from 10 to 20 inches. Reaction is slightly acid to strongly acid throughout the profile.

The A1 horizon has hue of 7.5YR or 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 or 4. The content of sandstone fragments more than 3 inches in diameter is less than 15 percent by volume.

The B2 horizon has hue of 5YR or 7.5YR, value of 4 to 6 (5 to 7 dry), and chroma of 4 to 6. The content of sandstone fragments less than 3 inches in diameter is less than 20 percent by volume.

Dennis series

The Dennis series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 7 percent.

Dennis soils are similar to Catoosa and Kenoma soils and are commonly adjacent to Bates, Eram, and Kenoma soils. Bates, Eram, and Catoosa soils are underlain by bedrock within a depth of 40 inches. They generally are on ridges. Kenoma soils lack a B1 horizon. They are on broad ridgetops.

Typical pedon of Dennis silt loam, 1 to 4 percent slopes, 400 feet west and 150 feet south of the northeast corner of sec. 10, T. 31 S., R. 15 E.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.

A12—8 to 13 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; few fine brown (10YR 4/3) coatings on faces of peds in the lower 3 inches; moderate medium and fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

B1—13 to 19 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/6) and distinct reddish brown (5YR 4/4) mottles; moderate medium and fine subangular blocky structure; slightly hard, friable; many fine roots; few worm casts; gray silt grains on faces of peds in the upper 2 inches; strongly acid; gradual smooth boundary.

B21t—19 to 35 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common medium distinct dark grayish brown (2.5Y 4/2) mottles; moderate medium and fine blocky structure; very hard, firm; many fine roots; clay films on faces of most peds; few black stains and masses; slightly acid; gradual smooth boundary.

B22t—35 to 46 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common coarse distinct brownish yellow (10YR 6/6) mottles; moderate medium blocky structure; very hard, firm; few fine roots; clay films on faces of peds; few fine soft black concretions; slightly acid; gradual smooth boundary.

B3—46 to 60 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; common coarse faint brown

(10YR 5/3) mottles; moderate medium blocky structure; very hard, firm; mildly alkaline.

The solum is more than 60 inches thick. The mollic epipedon ranges from 10 to 20 inches in thickness and in places extends into the upper part of the B1 horizon.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It ranges from neutral to strongly acid. The B1 horizon has color of 10YR 3/3, 4/3, or 3/4 or of 7.5YR 4/4 or 5/4. It ranges from medium acid to very strongly acid.

The B2t horizon has color of 10YR 4/3, 5/3, 4/4, or 5/4 or of 7.5YR 4/4 or 5/4. It is slightly acid to strongly acid. It is silty clay or silty clay loam.

Eram series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 7 percent.

Eram soils are similar to Kenoma and Zaar soils and are commonly adjacent to Bates, Dennis, and Talihina soils. Kenoma, Zaar, and Dennis soils have a solum that is more than 40 inches thick. They are below the Eram soils on the landscape. Bates soils are moderately deep over sandstone and sandy and silty shale. Their positions on the landscape are similar to those of the Eram soils. Talihina soils lack an argillic horizon and are underlain by shale within a depth of 20 inches. They are steeper than the Eram soils.

Typical pedon of Eram silty clay loam, 1 to 4 percent slopes, 150 feet east and 200 feet south of the northwest corner of sec. 27, T. 31 S., R. 16 E.

A1—0 to 11 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

B21t—11 to 17 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; common medium distinct dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) mottles; moderate medium granular and fine blocky structure; very hard, firm; common fine roots; medium acid; gradual smooth boundary.

B22t—17 to 25 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common medium distinct yellowish brown (10YR 5/4) mottles; moderate medium and fine blocky structure; very hard, firm; common fine roots; medium acid; gradual smooth boundary.

B3—25 to 32 inches; grayish brown (10YR 5/2) silty clay, light olive brown (2.5Y 5/4) dry; common fine faint brown (10YR 5/3) mottles; weak fine subangular blocky and blocky structure; very hard, firm; few fine roots; about 10 percent shale fragments; strongly acid; gradual smooth boundary.

Cr—32 inches; light olive brown soft shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 20 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is slightly acid or medium acid. In some areas sandstone fragments cover as much as 5 percent of the surface and make up as much as 5 percent of the A horizon.

The B2t horizon has hue of 2.5Y or 10YR, value of 3 or 4 (4 to 6 dry), and chroma of 2 or 3. It ranges from strongly acid to neutral. In some pedons seams of calcium carbonate are in the lower part of the B2t horizon and extend into the Cr horizon.

Kenoma series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old alluvium that has a high content of silt and clay. Slope is 0 to 2 percent.

Kenoma soils are similar to Dennis, Eram, Parsons, and Woodson soils and are commonly adjacent to those soils. Dennis soils have a B1 horizon. Eram soils are less than 40 inches deep over bedrock. Parsons soils have an A2 horizon. Woodson soils have chroma of 1 or less in the lower part of the mollic epipedon. Dennis and Eram soils are slightly lower on the landscape than the Kenoma soils, and Parsons and Woodson soils are less sloping.

Typical pedon of Kenoma silt loam, 0 to 2 percent slopes, 2,200 feet west and 100 feet north of the southeast corner of sec. 1, T. 31 S., R. 14 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

A12—6 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; dark gray (10YR 4/1) silt coatings on faces of peds; weak fine and medium granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt smooth boundary.

B21t—12 to 21 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; few vertical streaks of very dark brown (10YR 2/2) silt loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine and very fine subangular blocky and blocky structure; hard, firm; common fine roots; few fine black concretions; common black streaks; clay films on faces of peds; slightly acid; gradual wavy boundary.

B22t—21 to 44 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; few vertical streaks of very dark brown (10YR 2/2) silt loam; few fine distinct strong brown (7.5YR 5/6)

mottles; weak medium subangular blocky and blocky structure; very hard, very firm; common fine roots; thin clay films on faces of peds; few fine black concretions; few rounded chert pebbles less than half an inch in diameter; neutral; gradual wavy boundary.

B3—44 to 60 inches; dark brown (7.5YR 4/4) silty clay, reddish yellow (7.5YR 6/6) dry; few vertical streaks of very dark brown (10YR 2/2) silt loam; weak fine blocky structure; very hard, very firm; few fine roots; less than 5 percent rounded chert pebbles less than half an inch in diameter; mildly alkaline.

The solum is more than 40 inches thick. The mollic epipedon ranges from 10 to more than 20 inches in thickness. The content of fine and medium chert fragments is less than 10 percent throughout some pedons.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It is dominantly silt loam but in some pedons is silty clay loam. It is strongly acid to slightly acid.

The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 6. It ranges from strongly acid to neutral.

Lanton series

The Lanton series consists of deep, somewhat poorly drained, slowly permeable soils on flood plains along streams. They formed in silty and clayey alluvium. Slope is 0 to 2 percent.

Lanton soils are similar to Verdigris soils and are commonly adjacent to Mason, Osage, and Verdigris soils. Mason soils have an argillic horizon. They are well drained and are on stream terraces. Osage soils contain more clay than the Lanton soils and are somewhat lower on the landscape. Verdigris soils are moderately well drained and are on flood plains.

Typical pedon of Lanton silty clay loam, 1,600 feet east and 100 feet north of the southwest corner of sec. 21, T. 31 S., R. 14 E.

A11—0 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to moderate medium granular; hard, firm; many fine roots; slightly acid; gradual smooth boundary.

A12—12 to 24 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; hard, firm; common fine roots; slightly acid; gradual smooth boundary.

A13—24 to 32 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; common medium and fine distinct very dark gray (2.5Y 3/0) and dark yellowish brown (10YR 4/4) mottles; moderate medium granular structure; hard, firm; common fine roots; slightly acid; gradual smooth boundary.

C1g—32 to 45 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; common fine and medium distinct yellowish brown (10YR 5/6) and very dark gray (2.5Y 3/0) mottles; weak medium blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

C2g—45 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common medium distinct yellowish brown (10YR 5/6) and few fine faint dark gray (2.5Y 4/0) mottles; massive; hard, firm; scattered black coatings and fine concretions; slightly acid.

The solum is more than 40 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silty clay loam but in some pedons is silt loam. It is strongly acid to slightly acid.

The C horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), chroma of 1 or 2 and is commonly mottled with red, brown, and gray. It is silty clay loam or silty clay. It is medium acid or slightly acid.

Mason series

The Mason series consists of deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in silty alluvium. Slope is 0 to 2 percent.

Mason soils are similar to Verdigris soils and are commonly adjacent to Lanton, Osage, and Verdigris soils on flood plains and low stream terraces. These adjacent soils lack an argillic horizon. Also, Osage soils are more clayey than the Mason soils.

Typical pedon of Mason silt loam, 1,800 feet north and 400 feet east of the southwest corner of sec. 12, T. 34 S., R. 13 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; common fine roots; scattered worm casts; slightly acid; clear smooth boundary.

A12—8 to 18 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; common fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

B21t—18 to 30 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; slightly hard, friable; common fine roots; few worm casts; thin clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—30 to 44 inches; dark brown (10YR 4/3) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate

medium subangular blocky structure; slightly hard, friable; few fine roots; thin clay films on faces of peds; strongly acid; diffuse smooth boundary.

B3—44 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few fine faint strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable; strongly acid.

The solum ranges from 40 to more than 60 inches in thickness. The mollic epipedon is more than 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly silt loam but in some pedons is silty clay loam. It is neutral to medium acid.

The B2t horizon has hue of 10YR, value of 2 to 4 (3 to 5 dry), and chroma of 2 or 3. The lower part is mottled with brown, gray, or red in some pedons. The mottles are faint. This horizon is slightly acid to strongly acid.

Niotaze series

The Niotaze series consists of moderately deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in material weathered from shale interbedded with sandstone. Slope ranges from 8 to 20 percent.

Niotaze soils are commonly adjacent to Collinsville, Darnell, and Stephenville soils. These adjacent soils formed in material weathered from sandstone. Collinsville and Darnell soils are underlain by sandstone within a depth of 20 inches. They are on side slopes above the Niotaze soils. Stephenville soils are on ridgetops above the Niotaze soils.

Typical pedon of Niotaze cobbly fine sandy loam, in an area of Niotaze-Darnell complex, 8 to 20 percent slopes, 1,600 feet east and 50 feet north of the southwest corner of sec. 13, T. 32 S., R. 13 E.

A1—0 to 5 inches; dark brown (10YR 3/3) cobbly fine sandy loam, brown (10YR 5/3) dry; weak fine granular structure; soft, friable; many fine and medium roots; about 40 percent sandstone fragments; medium acid; clear smooth boundary.

A2—5 to 11 inches; brown (10YR 4/3) cobbly fine sandy loam, pale brown (10YR 6/3) dry; weak fine granular structure; slightly hard, friable; many fine and medium roots; about 35 percent sandstone fragments; medium acid; abrupt wavy boundary.

IIB2t—11 to 22 inches; yellowish red (5YR 5/6) silty clay, reddish yellow (5YR 6/6) dry; strong medium and fine blocky structure; extremely hard, very firm; many fine roots; clay films on faces of peds; slightly acid; gradual wavy boundary.

IIB3—22 to 32 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common fine distinct yellowish red (5YR 5/6) and common fine faint dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; clay films on faces of peds; slightly acid; gradual smooth boundary.

IICr—32 inches; yellowish brown (10YR 5/6) weakly laminated silty shale.

The depth to shale ranges from 20 to 40 inches. Sandstone fragments are on the surface and throughout the profile. In some pedons as much as 1 inch of organic litter is at the surface.

The A1 horizon has hue of 10YR, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It is medium acid or strongly acid. The A2 horizon has hue of 10YR or 7.5YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 or 3. It is medium acid or strongly acid.

The B horizon has hue of 2.5YR to 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. It is silty clay or silty clay loam. It is neutral to medium acid.

Olpe series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in gravelly old alluvial sediments. Slope ranges from 2 to 6 percent.

Olpe soils are adjacent to Bates, Dennis, and Kenoma soils. These adjacent soils do not contain chert gravel. They generally are in the less sloping areas above or below the Olpe soils.

Typical pedon of Olpe gravelly silt loam, in an area of Olpe-Dennis complex, 2 to 6 percent slopes, 1,300 feet west and 350 feet south of the northeast corner of sec. 6, T. 31 S., R. 16 E.

A1—0 to 16 inches; dark brown (7.5YR 3/2) gravelly silt loam, brown (7.5YR 5/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; about 40 percent, by volume, rounded chert gravel; slightly acid; gradual wavy boundary.

B1—16 to 21 inches; dark reddish brown (5YR 3/2) very gravelly silty clay loam, reddish brown (5YR 5/3) dry; moderate medium subangular blocky structure; hard, firm; common fine roots; about 85 percent, by volume, rounded chert gravel; medium acid; gradual wavy boundary.

B21t—21 to 30 inches; reddish brown (5YR 4/4) very gravelly silty clay, reddish brown (5YR 5/4) dry; moderate fine blocky structure; extremely hard, very firm; few fine roots; continuous clay films on faces of peds; about 85 percent, by volume, rounded chert gravel; medium acid; gradual wavy boundary.

B22t—30 to 43 inches; yellowish red (5YR 4/6) very gravelly silty clay, yellowish red (5YR 5/6) dry; moderate medium blocky structure; extremely hard, very firm; few fine roots; continuous clay films on faces of peds; about 80 percent, by volume, rounded chert gravel; medium acid; gradual wavy boundary.

B3—43 to 60 inches; coarsely mottled yellowish red (5YR 5/6), yellowish brown (10YR 5/6), and light yellowish brown (2.5Y 6/3), moist or dry, very gravelly silty clay; weak medium blocky structure; extremely hard, very firm; common medium black threads and concretions; few fine roots; thin patchy clay films on faces of peds; about 60 percent, by volume, rounded chert gravel; neutral.

The solum is more than 60 inches thick. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. It is dominantly gravelly silt loam but in some pedons is silt loam. It is strongly acid to slightly acid.

The B2t horizon has hue of 5YR or 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 4 to 6. It is medium acid to neutral.

Osage series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slope is 0 to 2 percent.

Osage soils are similar to Zaar soils and are commonly adjacent to Lanton, Mason, and Verdigris soils. Zaar soils are not gleyed in the lower horizons. They are on uplands. Lanton, Mason, and Verdigris soils contain less clay in the control section than the Osage soils. Mason and Lanton soils are on the higher parts of the landscape, and Verdigris soils are in the somewhat higher convex areas.

Typical pedon of Osage silty clay, 1,400 feet south and 150 feet west of the northeast corner of sec. 32, T. 31 S., R. 16 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; very hard, very firm; many fine roots; slightly acid; clear smooth boundary.

A12—6 to 10 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong fine granular structure; very hard, very firm; many fine roots; slightly acid; gradual smooth boundary.

A13—10 to 15 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; few fine distinct dark brown (10YR 3/3) mottles; strong fine granular and subangular blocky structure; very hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

B21g—15 to 34 inches; very dark gray (10YR 3/1) silty clay; few medium faint dark gray (N 4/0) and few fine distinct dark brown (10YR 4/3) mottles; moderate fine and medium blocky structure; very hard, very firm; few fine roots; few slickensides; a few vertical cracks filled with darker material; neutral; diffuse smooth boundary.

B22g—34 to 52 inches; very dark gray (10YR 3/1) silty clay; common fine faint dark gray (N 4/0) mottles; weak fine and medium blocky structure; extremely hard, very firm; slightly acid; diffuse smooth boundary.

B23g—52 to 60 inches; very dark gray (10YR 3/1) silty clay; common medium faint dark gray (5Y 4/1) mottles; weak medium and coarse blocky structure; extremely hard, extremely firm; slightly acid.

The solum is more than 40 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is dominantly silty clay but in some pedons is silty clay loam. It ranges from strongly acid to neutral. The B horizon is neutral in hue or has hue of 10YR to 5Y, value of 3 or 4, and chroma of less than 2. It is medium acid to neutral.

Parsons series

The Parsons series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium or clay beds. Slope is 0 to 1 percent.

Parsons soils are similar to Kenoma and Woodson soils and are commonly adjacent to Kenoma and Zaar soils. None of the similar or adjacent soils have an A2 horizon. Kenoma soils have chroma of 2 or more in the argillic horizon. They commonly are more sloping than the Parsons soils and are higher or lower on the landscape. Woodson soils are in positions on the landscape similar to those of the Parsons soils. Zaar soils are in convex areas and swales.

Typical pedon of Parsons silt loam, 2,000 feet south and 800 feet west of the northeast corner of sec. 7, T. 34 S., R. 17 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.

A2—7 to 12 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few medium faint brown (10YR 4/3) mottles; weak medium granular structure; slightly hard, friable; many fine roots; medium acid; abrupt smooth boundary.

B21tg—12 to 21 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; common fine distinct reddish brown (5YR 4/4) mottles; moderate medium and fine blocky structure; extremely hard, very firm; common fine roots; clay films on faces of peds; medium acid; gradual smooth boundary.

B22tg—21 to 36 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (10YR 6/2) dry; common fine distinct brown (10YR 5/3) and light gray (10YR 7/2) mottles; moderate medium blocky structure; extremely hard, very firm; few fine roots; clay films

on faces of peds; medium acid; gradual smooth boundary.

B3g—36 to 52 inches; gray (10YR 5/1) silty clay, light brownish gray (10YR 6/2) dry; common fine and medium distinct brown (10YR 5/3) mottles; weak coarse blocky structure; extremely hard, very firm; a few vertical cracks filled with lighter colored material; strongly acid; gradual smooth boundary.

C—52 to 60 inches; coarsely mottled gray (10YR 6/1), reddish yellow (7.5YR 6/6), and yellowish red (5YR 5/6) silty clay; massive; extremely hard, very firm; few fine black concretions; strongly acid.

The solum ranges from 40 to more than 60 inches in thickness. The Ap or A1 horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2. It is strongly acid to slightly acid. The A2 horizon has hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. It is strongly acid or medium acid.

The B2tg horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. It is mottled with shades of gray, brown, or red. It is strongly acid to slightly acid. The B3g and C horizons have matrix colors similar to those of the B2tg horizon and are mottled with shades of gray and brown. They range from strongly acid to neutral.

Shidler series

The Shidler series consists of shallow, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 1 to 4 percent.

Shidler soils are similar to Collinsville soils and are commonly adjacent to Catoosa, Kenoma, and Zaar soils. Collinsville soils are shallow over sandstone. They generally are steeper than the Shidler soils. Catoosa soils have a subsoil and are more than 20 inches deep over bedrock. Kenoma and Zaar soils have a clayey subsoil and are more than 40 inches deep over bedrock. Catoosa and Kenoma soils are on the higher parts of the landscape, and Zaar soils are along drainageways.

Typical pedon of Shidler silt loam, in an area of Shidler-Catoosa silt loams, 1 to 4 percent slopes, 2,000 feet east and 100 feet north of the southwest corner of sec. 30, T. 31 S., R. 15 E.

A1—0 to 11 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate and strong medium granular structure; slightly hard, friable; many fine roots; about 20 percent, by volume, flat limestone fragments on the surface and throughout the horizon; slightly acid; gradual smooth boundary.

R—11 inches; hard fractured limestone.

The thickness of the solum, or the depth to hard limestone, ranges from 4 to 20 inches. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It is slightly acid or neutral. It is dominantly silt loam but in some pedons is silty clay loam. The content of thin, flat limestone fragments that range from 3 to 15 inches along the longer axis is, by volume, less than 20 percent.

Stephenville series

The Stephenville series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 1 to 5 percent.

Stephenville soils are similar to Bates and Darnell soils and are commonly adjacent to Bates, Darnell, and Niotaze soils. Bates soils lack an A2 horizon. They are in positions on the landscape similar to those of the Stephenville soils or are on higher lying side slopes. Darnell soils lack an argillic horizon and are shallow over sandstone. Niotaze soils have a fine textured control section. Darnell and Niotaze soils are on side slopes below the Stephenville soils.

Typical pedon of Stephenville fine sandy loam, in an area of Stephenville-Darnell fine sandy loams, 1 to 5 percent slopes, 2,200 feet south and 100 feet east of the northwest corner of sec. 24, T. 32 S., R. 13 E.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

A2—7 to 17 inches; brown (7.5YR 5/2) fine sandy loam, light brown (7.5YR 6/4) dry; massive; soft, friable; many fine roots; slightly acid; clear smooth boundary.

B21t—17 to 22 inches; yellowish red (5YR 4/6) sandy clay loam, reddish yellow (5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable; many fine roots; thin patchy clay films; about 2 percent sandstone fragments; medium acid; gradual smooth boundary.

B22t—22 to 30 inches; yellowish red (5YR 4/8) sandy clay loam, reddish yellow (5YR 6/8) dry; few fine black stains; moderate medium subangular blocky structure; slightly hard, friable; thin patchy clay films on faces of peds; about 2 percent sandstone fragments; medium acid; gradual smooth boundary.

Cr—30 inches; soft sandstone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. In some pedons scattered sandstone fragments are on the surface and throughout the solum.

The A1 horizon has hue of 7.5YR or 10YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. It is dominantly fine sandy loam but in some pedons is loamy fine sand. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6 (6 to 8 dry), and chroma of 2 or 3. The A horizon is strongly acid to slightly acid.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5 (6 to 8 dry), and chroma of 4 to 8. It is strongly acid or medium acid.

Talihina series

The Talihina series consists of shallow, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale and thin layers of sandstone. Slope ranges from 10 to 30 percent.

Talihina soils are commonly adjacent to Collinsville and Eram soils. Collinsville soils have a loamy control section. Their positions on the landscape are similar to those of the Talihina soils. Eram soils have an argillic horizon. They are less sloping than the Talihina soils and are higher or lower on the landscape.

Typical pedon of Talihina silty clay loam, in an area of Talihina-Shale outcrop complex, 10 to 50 percent slopes, 500 feet north and 200 feet west of the southeast corner of sec. 32, T. 31 S., R. 17 E.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; hard, friable; many fine roots; slightly acid; gradual wavy boundary.

B2—7 to 14 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine faint dark gray (10YR 4/1) and distinct yellowish brown (10YR 5/6) mottles in the lower part; moderate medium granular and fine blocky structure; very hard, firm; many fine roots; about 2 percent small shale fragments; neutral; gradual wavy boundary.

C—14 to 17 inches; light olive brown (2.5Y 5/4) silty clay, light brownish gray (2.5Y 6/2) dry; common fine distinct yellowish brown (10YR 5/6) and few fine faint gray (N 5/0) mottles; massive; very hard, firm; few fine roots; about 8 percent small shale fragments; slightly acid; clear wavy boundary.

Cr—17 inches; light olive brown (2.5Y 5/4) soft shale; lenses of calcareous material; mildly alkaline.

The thickness of the solum and the depth to bedrock range from 10 to 20 inches. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly silty clay loam but in some pedons is silty clay. It ranges from neutral to strongly acid. The B2 horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It ranges from neutral to strongly acid.

Verdigris series

The Verdigris series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slope is 0 to 2 percent.

Verdigris soils are similar to Lanton and Mason soils and are commonly adjacent to Lanton, Mason, and Osage soils. Lanton soils have a subsoil. They are somewhat poorly drained and generally are on the parts of flood plains away from the stream channel. Mason soils have an argillic horizon. They are on stream terraces. Osage soils have a clayey subsoil. They are in concave areas on flood plains.

Typical pedon of Verdigris silt loam, 2,200 feet south and 2,300 feet east of the northwest corner of sec. 6, T. 32 S., R. 14 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.

A12—7 to 28 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; many fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

AC—28 to 46 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; weak medium granular structure; slightly hard, friable; few fine roots; scattered worm casts; slightly acid; gradual smooth boundary.

C—46 to 60 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; massive; slightly hard, friable; few fine pores; slightly acid.

The solum and the mollic epipedon range from 24 to more than 50 inches in thickness. Reaction is medium acid to neutral to a depth of 50 inches or more.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 6 dry), and chroma of 1 to 3. It is dominantly silt loam but in some pedons is silty clay loam.

The C horizon has hue of 2.5Y or 10YR, value of 3 to 5 (4 to 7 dry), and chroma of 2 or 3. It is silt loam or silty clay loam.

Woodson series

The Woodson series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium or clay beds. Slope is 0 to 1 percent.

Woodson soils are similar to Kenoma and Parsons soils and are commonly adjacent to Kenoma and Zaar soils. Kenoma and Parsons soils have chroma of 2 or more in the Bt horizon. Also, Parsons soils have an A2 horizon. Their positions on the landscape are similar to those of the Woodson soils. Kenoma soils are on the higher convex ridges. Zaar soils lack an abrupt textural change between the A horizon and the Bt horizon. They are in depressions and drainageways.

Typical pedon of Woodson silt loam, 1,400 feet south and 300 feet east of the northwest corner of sec. 21, T. 33 S., R. 15 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; abrupt smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, friable; common fine roots; scattered worm casts; slightly acid; abrupt smooth boundary.

B21t—11 to 19 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine faint dark brown (10YR 3/3) mottles; moderate fine blocky structure; extremely hard, very firm; common fine roots; clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—19 to 33 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; many medium distinct strong brown (7.5YR 5/6) and few medium distinct olive brown (2.5Y 4/4) mottles; moderate and weak fine and medium blocky structure; extremely hard, very firm; few fine roots; clay films on faces of peds; few fine black concretions; less than 2 percent small chert pebbles; medium acid; gradual smooth boundary.

B31—33 to 46 inches; dark grayish brown (2.5Y 4/2) silty clay, light gray (2.5Y 6/1) dry; few medium distinct dark reddish brown (5YR 3/4) and dark gray (N 4/0) mottles; weak medium blocky structure; extremely hard, very firm; few fine roots; clay films on faces of most peds; few fine black concretions; common fine gypsum particles; less than 2 percent small chert pebbles; medium acid; diffuse wavy boundary.

C—46 to 60 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; many medium distinct yellowish brown (10YR 5/6) mottles; moderate fine and very fine blocky structure; extremely hard, very firm; very few roots; common fine black concretions; medium acid.

The solum is more than 40 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or less. It is dominantly silt loam but in some pedons is silty clay loam. Unless limed, it is medium acid or slightly acid.

The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of dominantly 1.5 or less. In some pedons the lower part of this horizon has chroma of 2 or 3. The B horizon is medium acid to neutral.

Zaar series

The Zaar series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 0 to 4 percent.

Zaar soils are similar to Eram and Osage soils and are commonly adjacent to Catoosa, Parsons, Shidler, and Woodson soils. Eram soils are moderately deep over soft shale. Osage soils are poorly drained and are on flood plains. Catoosa, Parsons, Shidler, and Woodson soils have an argillic horizon. Parsons and Woodson soils are on broad ridgetops, and Catoosa, Eram, and Shidler soils are on side slopes.

Typical pedon of Zaar silty clay, 1 to 4 percent slopes, 700 feet west and 200 feet north of the southeast corner of sec. 10, T. 31 S., R. 15 E.

Ap—0 to 6 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong medium granular and fine blocky structure; hard, firm; many fine roots; slightly acid; clear smooth boundary.

A12—6 to 14 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine and medium blocky structure; hard, firm; many fine roots; slightly acid; gradual wavy boundary.

B21—14 to 25 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; few fine faint reddish brown (5YR 4/3) mottles; moderate medium blocky structure; very hard, firm; few small black concretions; few slickensides; many fine roots; neutral; gradual wavy boundary.

B22—25 to 36 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine faint reddish brown (5YR 4/3) and few fine faint dark gray (N 4/0) mottles; moderate medium and fine blocky structure; very hard, firm; few small black concretions; few fine roots; large vertical cracks filled with darker material from the horizons above; neutral; gradual wavy boundary.

B3—36 to 49 inches; olive brown (2.5Y 4/4) silty clay, light olive brown (2.5Y 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few small black concretions; few slickensides; large vertical cracks filled with darker material; neutral; gradual wavy boundary.

C1—49 to 60 inches; mixed olive brown (2.5Y 4/4) and dark yellowish brown (10YR 4/6) silty clay, light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/8) dry; vertical cracks filled with darker material; massive; extremely hard, firm; neutral.

The solum is more than 40 inches thick. The depth to weathered shale is more than 45 inches. In some pedons small, hard carbonate concretions are in the lower horizons.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is dominantly silty clay but in some pedons is silty clay loam. It is medium acid or slightly acid.

The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 2 to 4. It is neutral or slightly acid. In some pedons the lower part of this horizon is silty clay loam.

factors of soil formation

Soil forms when soil-forming processes act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

parent material

Parent material is the unconsolidated mass in which the soil forms. It determines to a large extent the mineralogical and chemical composition of the soil and the rate at which soil-forming processes take place. It affects the texture, structure, color, natural fertility, and other properties of soils. Among the agents of mechanical weathering are temperature changes, freezing of water, formation of crystals, the actions of plants and animals, wetting and drying, abrasion, and corrosion. Chemical weathering generally results in the reduction of particle sizes, the addition of water, oxygen, and carbon dioxide, and the loss of soluble salts of such metallic elements as sodium and potassium. If the climate is temperate, clay minerals commonly result from chemical weathering, which can markedly alter the color and general appearance of a deposit.

Most of the soils in Montgomery County formed in material weathered from Upper Pennsylvanian limestone, sandstone, and shale. Some formed in recent alluvium and some in deposits of smooth chert gravel in the central part of the county. The chert gravel is tertiary material. The alluvial sediment that weathered in these deposits is the parent material of Olpe soils.

Dennis, Eram, Talihina, and Zaar soils formed in material weathered from shale. Bates, Collinsville, Darnell, Niotaze, and Stephenville soils formed in material weathered from sandstone and sandy shale. Catoosa and Shidler soils formed in material weathered from limestone. Kenoma, Parsons, and Woodson soils formed in old alluvium. Lanton, Mason, Osage, and Verdigris soils formed in recent alluvium along streams.

climate

Climate directly affects soil formation by weathering the parent material. It indirectly affects soil formation through its effect on plants and animals.

The climate of Montgomery County is continental. It is characterized by intermittent dry and moist periods, which can last for less than a year or for several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. As a result of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons of some soils.

plant and animal life

Plants and animals have an important effect on soil formation. Plants generally affect the amount of nutrients and of organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Earthworms in Verdigris soils have left many worm casts. Bacteria and fungi help to decompose the plants, thus releasing more nutrients for plant food.

The mid and tall prairie grasses have had the greatest effect on soil formation in Montgomery County. As a result of the grasses, the upper part of a typical soil in the county is dark and has a high content of organic matter. The next part in many places is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color and high in content of carbonates.

relief

Relief affects soil formation through its effect on drainage, runoff, plant cover, and soil temperature. The soil temperature, for example, is slightly lower on the east- and north-facing slopes than on the west- and south-facing slopes. Most important is the effect that relief has had on the movement of water on the surface and into the soil.

The runoff rate is higher on the steeper soils in the uplands than on the less steep soils. As a result, erosion is more extensive. Relief has retarded the formation of Talihina soils, which formed in the oldest parent material in the county. Runoff is rapid on these strongly sloping to steep soils, and much of the soil material is removed as soon as the soil forms.

Soils having distinct horizons generally formed in the less sloping areas. The nearly level Mason soils on stream terraces, for example, formed in the younger parent material in the county but have distinct horizons. Most of the precipitation received by these soils penetrates the surface.

time

Differences in the length of time that the parent materials have been in place commonly are reflected in the degree of profile development. Some soils form rapidly; others form slowly. The soils in Montgomery County range from immature to mature. Those on low bottoms, such as Verdigris soils, are subject to stream overflow. They receive new sediment with each flood. As a result, they are immature. They have a thick, dark surface layer, but the soil structure is weak. Kenoma soils are considered mature because they have distinct horizons.

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glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedding. Draining the soil through a series of broad beds made by plowing, grading, or otherwise elevating the surface of a flat field.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are

free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray or dull colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from

that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Controlling the intensity of grazing so that the plant cover protects the soil, the quality of desirable vegetation is improved or maintained, and the quantity is increased or maintained.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope (in tables). Slope is great enough for special practices to be needed to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently referred to as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisons of this horizon (A1, A2, and A3).

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to

the contour. The terrace intercepts surface runoff so that the water can soak into the soil or flow slowly to a prepared outlet.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	44.8	23.0	33.9	73	-5	1.25	0.36	1.68	2	2.8
February---	50.6	27.5	39.0	75	4	1.16	0.61	1.84	2	2.1
March------	58.0	34.0	46.0	86	5	2.22	1.27	3.07	4	3.0
April------	70.5	46.9	58.7	91	26	3.95	2.02	6.05	6	0.2
May--------	78.1	56.1	67.1	91	35	5.10	2.69	6.71	7	0.0
June-------	85.9	65.0	75.5	99	47	5.49	2.97	8.31	7	0.0
July-------	91.5	68.8	80.2	104	54	3.82	1.87	7.22	5	0.0
August-----	91.8	67.6	79.7	107	51	2.97	1.44	4.38	5	0.0
September--	83.7	58.9	71.3	100	39	4.68	1.68	7.28	5	0.0
October----	73.8	48.1	61.0	91	27	3.26	0.60	5.36	4	0.0
November---	59.2	35.3	47.3	81	12	1.69	0.20	3.29	3	0.5
December---	48.0	26.7	37.4	74	-2	1.36	0.72	1.86	3	2.3
Year-----	69.7	46.49	58.09	107	-5	36.95	28.68	45.94	53	10.9

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 15	April 26	April 28
2 years in 10 later than--	April 1	April 11	April 23
5 years in 10 later than--	March 23	April 1	April 13
First freezing temperature in fall:			
1 year in 10 earlier than--	October 29	October 19	October 12
2 years in 10 earlier than--	November 2	October 24	October 16
5 years in 10 earlier than--	November 12	November 2	October 26

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	207	194	175
8 years in 10	216	201	182
5 years in 10	234	215	196
2 years in 10	250	227	207
1 year in 10	259	234	215

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bates loam, 1 to 3 percent slopes	15,400	3.7
Bb	Bates loam, 3 to 6 percent slopes	19,000	4.6
Bc	Bates loam, 2 to 6 percent slopes, eroded	1,450	0.4
Bf	Bates-Collinsville complex, 1 to 4 percent slopes	17,000	4.1
Bg	Bates-Collinsville complex, 4 to 20 percent slopes	32,000	7.7
Bu	Bates-Urban land complex, 2 to 6 percent slopes	2,550	0.6
Ca	Catoosa silt loam, 0 to 2 percent slopes	14,000	3.4
Db	Dennis silt loam, 1 to 4 percent slopes	35,000	8.4
Dc	Dennis silt loam, 4 to 7 percent slopes	6,600	1.6
Eb	Eram silty clay loam, 1 to 4 percent slopes	9,000	2.2
Ec	Eram silty clay loam, 2 to 6 percent slopes, eroded	2,200	0.5
Ef	Eram silty clay loam, 4 to 7 percent slopes	23,000	5.5
Et	Eram-Talihina silty clay loams, 6 to 20 percent slopes	20,000	4.8
Eu	Eram-Urban land complex, 2 to 6 percent slopes	3,900	0.9
Ka	Kenoma silt loam, 0 to 2 percent slopes	45,000	10.8
La	Lanton silty clay loam	12,100	2.9
Ma	Mason silt loam	5,300	1.3
Nd	Niotaze-Darnell complex, 8 to 20 percent slopes	9,300	2.2
Oa	Oil wasteland	170	*
Od	Olpe-Dennis complex, 2 to 6 percent slopes	2,460	0.6
Or	Orthents, clayey	6,900	1.7
Os	Osage silty clay	14,500	3.5
Pa	Parsons silt loam	6,500	1.6
Qu	Quarries	810	0.2
Sc	Shidler-Catoosa silt loams, 1 to 4 percent slopes	17,000	4.1
Sd	Stephenville-Darnell fine sandy loams, 1 to 5 percent slopes	9,300	2.2
Ts	Talihina-Shale outcrop complex, 10 to 50 percent slopes	6,100	1.5
Vb	Verdigris silt loam	23,200	5.6
Vc	Verdigris silt loam, channeled	3,400	0.8
Wo	Woodson silt loam	18,000	4.3
Za	Zaar silty clay, 0 to 1 percent slopes	1,780	0.4
Zb	Zaar silty clay, 1 to 4 percent slopes	19,000	4.6
	Water	13,440	3.3
	Total	415,360	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum	Corn	Winter wheat	Soybeans	Tall fescue	Alfalfa hay
	Bu	Bu	Bu	Bu	AUM*	Ton
Ba----------------------- Bates	55	50	36	30	5.5	3.0
Bb----------------------- Bates	50	45	32	20	5.5	2.5
Bc----------------------- Bates	40	35	28	14	5.0	2.5
Ca----------------------- Catoosa	65	60	40	26	5.5	3.5
Db----------------------- Dennis	75	70	40	30	6.0	4.0
Dc----------------------- Dennis	70	65	36	28	6.0	3.5
Eb----------------------- Eram	55	50	28	22	5.0	3.0
Ec----------------------- Eram	45	40	20	14	4.5	2.5
Ef----------------------- Eram	50	45	24	18	5.0	2.5
Ka----------------------- Kenoma	65	60	36	28	5.0	3.5
La----------------------- Lanton	100	95	36	34	7.5	4.0
Ma----------------------- Mason	105	100	42	36	7.5	5.5
Os----------------------- Osage	65	60	30	26	6.5	2.5
Pa----------------------- Parsons	70	65	36	28	5.0	3.5
Vb----------------------- Verdigris	100	95	40	34	7.5	5.5
Wo----------------------- Woodson	70	65	36	28	5.0	3.5
Za----------------------- Zaar	65	60	36	28	5.5	3.5
Zb----------------------- Zaar	60	55	34	24	5.5	3.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ba, Bb, Bc: Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	15
Bf*, Bg*:					
Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	15
Collinsville	Shallow Sandstone	Favorable	4,500	Little bluestem	30
		Normal	3,700	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
Ca: Catoosa	Loamy Upland	Favorable	6,500	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Sideoats grama	10
				Switchgrass	5
Db, Dc: Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Eb, Ec, Ef: Eram	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Et*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Talihina	Clay Upland	Favorable	5,500	Little bluestem	25
		Normal	4,000	Big bluestem	15
		Unfavorable	2,500	Switchgrass	15
				Indiangrass	10
				Sideoats grama	10
				Tall dropseed	5
Ka: Kenoma	Clay Upland	Favorable	6,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
La: Lanton	Loamy Lowland	Favorable	10,000	Prairie cordgrass	35
		Normal	8,000	Big bluestem	15
		Unfavorable	6,000	Switchgrass	15
				Indiangrass	10
				Eastern gamagrass	5
				Sedge	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ma: Mason	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	9,000	Indiangrass	20
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Nd*: Niotaze	Savannah	Favorable	5,000	Big bluestem	20
		Normal	3,800	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
Darnell	Shallow Savannah	Favorable	3,500	Big bluestem	20
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
				Purpletop	5
				Scribner panicum	5
				Tall dropseed	5
				Hairy sunflower	5
Od*: Olpe	Loamy Upland	Favorable	6,500	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	9,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Os: Osage	Clay Lowland	Favorable	9,000	Prairie cordgrass	40
		Normal	7,500	Switchgrass	15
		Unfavorable	6,000	Big bluestem	15
				Indiangrass	5
				Eastern gamagrass	5
				Sedge	5
Pa: Parsons	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Switchgrass	15
				Indiangrass	15
				Tall dropseed	5
				Sedge	5
Sc*: Shidler	Shallow Limy	Favorable	3,000	Sideoats grama	30
		Normal	2,000	Little bluestem	15
		Unfavorable	1,000	Big bluestem	15
				Indiangrass	10
				Switchgrass	5
Catoosa	Loamy Upland	Favorable	6,500	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Sideoats grama	10
				Switchgrass	5
Sd*: Stephenville	Savannah	Favorable	5,000	Big bluestem	25
		Normal	3,700	Little bluestem	15
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
Darnell	Shallow Savannah	Favorable	3,500	Little bluestem	25
		Normal	2,500	Big bluestem	15
		Unfavorable	1,500	Indiangrass	5
				Switchgrass	5
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ts*:					
Talihina	Clay Upland	Favorable	5,500	Little bluestem	25
		Normal	4,000	Big bluestem	15
		Unfavorable	2,500	Switchgrass	15
				Indiangrass	10
				Sideoats grama	10
				Tall dropseed	5
Shale outcrop.					
Vb, Vc Verdigris	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,500	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	5
Wo Woodson	Clay Upland	Favorable	6,500	Big bluestem	30
		Normal	4,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
Za, Zb Zaar	Clay Upland	Favorable	6,500	Big bluestem	30
		Normal	4,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
La------------------ Lanton	3o	Slight	Slight	Slight	Slight	Pin oak-------------	80	Pecan, green ash, American sycamore, eastern cottonwood, black walnut.
						Green ash-----------	75	
						Eastern cottonwood--	85	
						Pecan---------------	50	
						Common hackberry----	60	
Ma------------------ Mason	3o	Slight	Slight	Moderate	Moderate	Northern red oak----	65	Bur oak, green ash, black walnut, pecan, eastern cottonwood.
						Green ash-----------	75	
						Black walnut--------	70	
						Eastern cottonwood--	90	
Nd*: Niotaze------------	5x	Moderate	Moderate	Slight	Slight	Post oak------------	30	---
						Blackjack oak-------	25	
						Southern red oak----	35	
Darnell------------	5d	Moderate	Moderate	Moderate	Slight	Blackjack oak-------	30	---
						Post oak------------	30	
Os------------------ Osage	4w	Slight	Moderate	Severe	Severe	Pin oak-------------	75	Pin oak, pecan, common hackberry, green ash.
						Pecan---------------	50	
						Eastern cottonwood--	65	
						Green ash-----------	70	
Sd*: Stephenville------	5o	Slight	Slight	Slight	Slight	Post oak------------	35	---
						Blackjack oak-------	33	
Darnell------------	5d	Slight	Slight	Moderate	Slight	Post oak------------	30	---
						Blackjack oak-------	30	
Vb, Vc-------------- Verdigris	3o	Slight	Slight	Slight	Slight	Eastern cottonwood--	86	Eastern cottonwood, American sycamore, black walnut, bur oak, pecan.
						Bur oak-------------	65	
						Common hackberry----	70	
						Black walnut--------	70	
						Silver maple--------	60	
						Green ash-----------	60	
						White oak-----------	55	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
Ba, Bb, Bc: Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Bf*, Bg*:					
Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Collinsville	---	---	Eastern redcedar, redbud, mulberry, northern red oak.	---	---
Bu*:					
Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Urban land.					
Ca: Catoosa	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Green ash, eastern redcedar, northern red oak, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Db, Dc: Dennis	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Common hackberry, pin oak.	Austrian pine, osageorange, green ash.	---
Eb, Ec, Ef: Eram	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Osageorange, honeylocust, common hackberry, pin oak.	Austrian pine, green ash.	---
Et*:					
Eram	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Osageorange, honeylocust, common hackberry, pin oak.	Austrian pine, green ash.	---
Talihina	Fragrant sumac	Flowering dogwood	Eastern redcedar, redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Eu*:					
Eram	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Osageorange, honeylocust, common hackberry, pin oak.	Austrian pine, green ash.	---
Urban land.					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ka. Kenoma	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Common hackberry, pin oak, honeylocust.	Green ash, Austrian pine, Siberian elm.	---
La. Lanton	American plum, redosier dogwood.	Common chokecherry, autumn-olive.	Eastern redcedar, redbud.	Russian mulberry, green ash, honeylocust, golden willow.	Silver maple, eastern cottonwood.
Ma. Mason	Fragrant sumac, lilac.	Autumn-olive, Peking cotoneaster.	Eastern redcedar, radiant crabapple.	Austrian pine, Scotch pine, green ash, honeylocust.	Silver maple, eastern cottonwood.
Nd*:					
Niotaze	American plum, fragrant sumac.	Russian-olive, eastern redcedar, autumn-olive.	Common hackberry, pin oak, osage-orange, honeylocust.	Siberian elm, Austrian pine, green ash.	---
Darnell	---	---	Eastern redcedar, redbud, mulberry, northern red oak.	---	---
Oa*. Oil wasteland					
Od*:					
Olpe	Fragrant sumac	Flowering dogwood	Eastern redcedar, northern red oak, green ash, common hackberry.	Honeylocust	---
Dennis	Lilac, fragrant sumac.	Russian-olive, autumn-olive, common chokecherry.	Common hackberry, pin oak, honeylocust.	Austrian pine, osageorange, green ash, Siberian elm.	---
Or*. Orthents					
Os. Osage	American plum, redosier dogwood.	Common chokecherry, autumn-olive.	Eastern redcedar, redbud.	Russian-olive, green ash, honeylocust, golden willow.	Silver maple, eastern cottonwood.
Pa. Parsons	Lilac, fragrant sumac.	Russian-olive, autumn-olive, common chokecherry.	Eastern redcedar common hackberry, honeylocust.	Austrian pine, green ash, Siberian elm, osageorange.	---
Qu*. Quarries					
Sc*:					
Shidler	Fragrant sumac	Flowering dogwood	Eastern redcedar, redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Catoosa	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Sd*:					
Stephenville	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Darnell	---	---	Eastern redcedar, redbud, mulberry, northern red oak.	---	---
Ts*:					
Talihina	Fragrant sumac	Flowering dogwood	Eastern redcedar, redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Shale outcrop.					
Vb, Vc Verdigris	Fragrant sumac, lilac.	Peking cotoneaster, autumn-olive.	Eastern redcedar, radiant crab-apple.	Austrian pine, honeylocust, green ash, Scotch pine.	Silver maple, eastern cottonwood.
Wo Woodson	Fragrant sumac, lilac.	Russian-olive, autumn-olive, common choke-cherry.	Common hackberry, eastern redcedar, honeylocust.	Green ash, Austrian pine, Scotch pine, osageorange.	---
Za, Zb Zaar	Lilac, fragrant sumac.	Russian-olive, autumn-olive, common choke-cherry.	Eastern redcedar, common hackberry, honeylocust.	Green ash, Austrian pine, Scotch pine, osageorange.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Ba, Bb, Bc----- Bates	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight	Moderate: thin layer.
Bf*:					
Bates	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight	Moderate: thin layer.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones.	Slight	Severe: thin layer.
Bg*:					
Bates	Slight	Slight	Severe: slope.	Slight	Moderate: thin layer.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight	Severe: thin layer.
Bu*:					
Bates	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight	Moderate: thin layer.
Urban land.					
Ca----- Catoosa	Slight	Slight	Slight	Severe: erodes easily.	Moderate: thin layer.
Db, Dc----- Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.	Slight.
Eb, Ec, Ef----- Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.	Moderate: thin layer.
Et*:					
Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: thin layer.
Talihina	Severe: wetness.	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness, thin layer.
Eu*:					
Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.	Moderate: thin layer.
Urban land.					
Ka----- Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
La-------------------- Lanton	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
Ma-------------------- Mason	Severe: floods.	Moderate: percs slowly.	Moderate: percs slowly.	Severe: erodes easily.	Slight.
Nd*:					
Niotaze--------------	Severe: wetness.	Moderate: slope, wetness.	Severe: large stones, slope, small stones.	Moderate: wetness, large stones.	Severe: large stones.
Darnell--------------	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight------------	Severe: thin layer.
Oa*. Oil wasteland					
Od*:					
Olpe-----------------	Severe: small stones.	Severe: small stones.	Severe: small stones.	Slight------------	Severe: small stones.
Dennis---------------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.	Slight.
Or*. Orthents					
Os-------------------- Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
Pa-------------------- Parsons	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, erodes easily.	Severe: wetness.
Qu*. Quarries					
Sc*:					
Shidler--------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: erodes easily.	Severe: thin layer.
Catoosa--------------	Slight----------	Slight----------	Moderate: slope, depth to rock.	Severe: erodes easily.	Moderate: thin layer.
Sd*:					
Stephenville---------	Slight----------	Slight----------	Moderate: slope, depth to rock.	Slight------------	Moderate: thin layer.
Darnell--------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight------------	Severe: thin layer.
Ts*:					
Talihina-------------	Severe: slope, wetness.	Severe: slope, wetness.	Severe: slope, wetness.	Severe: wetness, slope.	Severe: wetness, slope, thin layer.
Shale outcrop.					

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Vb: Verdigris	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
Vc: Verdigris	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
Wo: Woodson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Za, Zb: Zaar	Severe: wetness, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ba, Bb, Bc: Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Bf*, Bg*:												
Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Collinsville	Poor	Poor	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Bu*:												
Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Urban land.												
Ca: Catoosa	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Db: Dennis	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Dc: Dennis	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Eb: Eram	Fair	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Ec: Eram	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Ef: Eram	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Et*:												
Eram	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Talihina	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Eu*:												
Eram	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Urban land.												
Ka: Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor	Fair.
La: Lanton	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Good.
Ma: Mason	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Nd*:												
Niotaze	Poor	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Darnell	Poor	Poor	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Fair.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Oa*. Oil wasteland												
Od*:												
Olpe	Fair	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.	Good.
Dennis	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Or*. Orthents												
Os: Osage	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Poor	Fair.
Pa: Parsons	Fair	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Good.
Qu*. Quarries												
Sc*:												
Shidler	Very poor.	Very poor.	Poor	Good	Good	Poor	Very poor.	Very poor.	Very poor.	Good	Very poor.	Poor.
Catoosa	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Sd*:												
Stephenville	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Darnell	Poor	Poor	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Fair.
Ts*:												
Talihina	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Shale outcrop.												
Vb, Vc: Verdigris	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Wo: Woodson	Good	Good	Fair	Poor	Poor	Fair	Poor	Good	Fair	Fair	Fair	Fair.
Za, Zb: Zaar	Fair	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ba: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Slight.
Bb, Bc: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight.
Bf*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Bg*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Bu*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight.
Urban land.					
Ca: Catoosa	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: low strength.
Db, Dc: Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Eb, Ec, Ef: Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Et*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Talihina	Severe: depth to rock, wetness.	Severe: wetness, shrink-swell.	Severe: wetness, depth to rock.	Severe: wetness, shrink-swell, slope.	Severe: low strength, wetness.
Eu*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Urban land.					
Ka: Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
La: Lanton	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ma: Mason	Slight	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Nd*:					
Niotaze	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell, slope.	Severe: low strength, shrink-swell.
Darnell	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope.
Oa*. Oil wasteland					
Od*:					
Olpe	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell.
Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Or*. Orthents					
Os: Osage	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.
Pa: Parsons	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.
Qu*. Quarries					
Sc*:					
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Catoosa	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: low strength.
Sd*:					
Stephenville	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Slight.
Darnell	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
Ts*:					
Talihina	Severe: depth to rock, wetness, slope.	Severe: wetness, shrink-swell, slope.	Severe: wetness, depth to rock, slope.	Severe: wetness, shrink-swell, slope.	Severe: low strength, wetness, slope.
Shale outcrop.					
Vb, Vc: Verdigris	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Wo----------------- Woodson	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.
Za, Zb------------ Zaar	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ba, Bb, Bc: Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Bf*:					
Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Bg*:					
Bates	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Collinsville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Bu*:					
Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Urban land.					
Ca: Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Db, Dc: Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Eb, Ec, Ef: Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Et*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Talihina	Severe: depth to rock, wetness.	Severe: depth to rock, slope.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Poor: area reclaim.
Eu*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Urban land.					
Ka: Kenoma	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
La: Lanton	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness, thin layer.
Ma: Mason	Severe: percs slowly.	Slight	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Nd*:					
Niotaze	Severe: depth to rock, percs slowly, wetness.	Severe: slope, depth to rock, wetness.	Severe: wetness, depth to rock.	Severe: wetness, depth to rock.	Poor: too clayey, area reclaim, hard to pack.
Darnell	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
Oa*. Oil wasteland					
Od*:					
Olpe	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight	Poor: too clayey, small stones.
Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Or*. Orthents					
Os: Osage	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.
Pa: Parsons	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Qu*. Quarries					
Sc*:					
Shidler	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Sd*:					
Stephenville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Poor: area reclaim.
Darnell	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ts*:					
Talihina	Severe: depth to rock, wetness, slope.	Severe: depth to rock, slope.	Severe: depth to rock, wetness, slope.	Severe: depth to rock, wetness, slope.	Poor: area reclaim, slope.
Shale outcrop.					
Vb, Vc Verdigris	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Wo Woodson	Severe: percs slowly, wetness.	Slight	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
Za Zaar	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Zb Zaar	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ba, Bb, Bc: Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Bf*, Bg*: Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Collinsville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Bu*: Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Urban land.				
Ca: Catoosa	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Db, Dc: Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Eb, Ec, Ef: Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Et*: Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Talihina	Poor: area reclaim, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones.
Eu*: Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Urban land.				
Ka: Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
La: Lanton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ma: Mason	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nd*:				
Niotaze	Poor: low strength, area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Darnell	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Oa*. Oil wasteland				
Od*:				
Olpe	Fair: shrink-swell.	Improbable: excess fines.	Probable	Poor: small stones, area reclaim.
Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Or*. Orthents				
Os: Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pa: Parsons	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Qu*. Quarries				
Sc*:				
Shidler	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Catoosa	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Sd*:				
Stephenville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Darnell	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Ts*:				
Talihina	Poor: area reclaim, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones.
Shale outcrop.				
Vb, Vc: Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Wo: Woodson	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Za, Zb: Zaar	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ba: Bates	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bb, Bc: Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Bf*:						
Bates	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Collinsville	Severe: depth to rock.	Slight	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bg*:						
Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Collinsville	Severe: depth to rock, slope.	Slight	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Bu*:						
Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Urban land.						
Ca: Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth.	Depth to rock, erodes easily.	Erodes easily, depth to rock, rooting depth.
Db: Dennis	Slight	Moderate: hard to pack, wetness.	Percs slowly	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Dc: Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Eb: Eram	Moderate: depth to rock.	Severe: thin layer.	Percs slowly, depth to rock.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Ec, Ef: Eram	Moderate: depth to rock, slope.	Severe: thin layer.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Et*:						
Eram	Moderate: depth to rock, slope.	Severe: thin layer.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Talihina	Severe: depth to rock, slope.	Severe: wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly.	Slope, depth to rock, erodes easily.	Wetness, slope, erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Eu*:						
Eram	Moderate: depth to rock, slope.	Severe: thin layer.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Urban land.						
Ka Kenoma	Slight	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
La Lanton	Slight	Severe: piping, wetness.	Percs slowly, floods.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
Ma Mason	Slight	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Nd*:						
Niotaze	Severe: slope.	Severe: thin layer.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, droughty.	Slope, large stones, depth to rock.	Slope, wetness, large stones.
Darnell	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Oa*. Oil wasteland						
Od*:						
Olpe	Moderate: slope.	Slight	Deep to water	Percs slowly, slope.	Percs slowly	Percs slowly.
Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Or*. Orthents						
Os Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, floods.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pa Parsons	Slight	Severe: wetness.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Qu*. Quarries						
Sc*:						
Shidler	Severe: depth to rock.	Slight	Deep to water	Depth to rock, erodes easily.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth.	Depth to rock, erodes easily.	Erodes easily, depth to rock, rooting depth.
Sd*:						
Stephenville	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Darnell	Severe: depth to rock.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ts*:						
Talihina	Severe: depth to rock, slope.	Severe: wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly.	Slope, depth to rock, erodes easily.	Wetness, slope, erodes easily.
Shale outcrop.						
Vb, Vc: Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Floods	Favorable	Favorable.
Wo: Woodson	Slight	Severe: wetness.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Percs slowly, wetness, erodes easily.
Za, Zb: Zaar	Slight	Moderate: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ba, Bb, Bc--------Bates	0-15	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	15-27	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6	0	85-100	85-100	80-100	45-85	25-40	3-15
	27	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bf*, Bg*:											
Bates------------	0-15	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	15-27	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6	0	85-100	85-100	80-100	45-85	25-40	3-15
	27	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Collinsville----	0-11	Fine sandy loam	SM, SC, ML, CL	A-4	0-3	80-100	60-100	60-95	36-75	<30	NP-10
	11-17	Fine sandy loam, loam, extremely stony fine sandy loam.	SM, SC, ML, CL	A-4	3-40	80-100	60-100	60-95	36-75	<30	NP-10
	17	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bu*:											
Bates------------	0-15	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	15-24	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6	0	85-100	85-100	80-100	45-85	25-40	3-15
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Urban land.											
Ca---------------Catoosa	0-10	Silt loam--------	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	10-31	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Db, Dc-----------Dennis	0-13	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	13-19	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	19-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Eb, Ec, Ef-------Eram	0-11	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	11-32	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
Et*:											
Eram------------	0-11	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	11-27	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	27	Weathered bedrock	---	---	---	---	---	---	---	---	---
Talihina--------	0-7	Silty clay loam	CL	A-6, A-7	0-15	87-100	87-100	85-100	70-98	37-50	15-26
	7-17	Silty clay, clay, clay loam.	CH, CL	A-6, A-7	0-15	87-100	87-100	87-100	70-90	37-50	15-26
	17	Weathered bedrock	---	---	---	---	---	---	---	---	---
Eu*:											
Eram------------	0-11	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	11-30	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	80-98	37-65	15-35
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Eu*: Urban land.											
Ka---------------- Kenoma	0-12	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	12-60	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
La---------------- Lanton	0-12	Silty clay loam	CL	A-4, A-6	0	100	95-100	90-100	80-95	25-38	8-15
	12-32	Silt loam, silty clay loam.	CL	A-4, A-6	0	100	95-100	85-100	80-95	30-38	8-16
	32-60	Clay, silty clay, silty clay loam.	CH, CL	A-6, A-7	0	100	95-100	85-100	75-95	40-55	18-28
Ma---------------- Mason	0-18	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-98	20-35	1-13
	18-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20
Nd*: Niotaze----------	0-11	Cobbly fine sandy loam.	SM, GM, GM-GC, SM-SC	A-2-4, A-4, A-1	25-50	50-75	50-75	35-60	15-45	<26	NP-7
	11-32	Silty clay, silty clay loam, clay.	CH, CL	A-7, A-6	0	95-100	95-100	90-100	90-100	35-65	15-40
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Darnell----------	0-6	Fine sandy loam	SM, SC, ML, CL	A-4	0-5	90-100	90-100	85-100	36-60	<30	NP-10
	6-16	Fine sandy loam, loam.	SM, SC, ML, CL	A-4	0-8	70-100	70-100	60-100	36-60	<30	NP-10
	16	Weathered bedrock	---	---	---	---	---	---	---	---	---
Oa*. Oil wasteland											
Od*: Olpe-------------	0-16	Gravelly silt loam.	GC, SC	A-2, A-4, A-6	0	30-75	30-75	20-55	15-50	20-30	7-15
	16-21	Very gravelly silty clay loam, very gravelly silty clay.	GC, SC, GP-GC, SP-SC	A-2, A-6, A-7	0	30-65	10-50	10-50	10-45	30-50	11-22
	21-60	Very gravelly silty clay, very gravelly clay.	GC, SC, GP-GC SP-SC	A-2-7, A-7	0	30-65	10-50	10-50	10-45	40-60	25-40
Dennis-----------	0-13	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	13-19	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	19-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Or*. Orthents											
Os---------------- Osage	0-15	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	15-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	50-80	30-55
Pa---------------- Parsons	0-12	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	96-100	96-100	80-97	20-37	1-12
	12-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	96-100	96-100	80-99	37-70	15-40

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Qu*. Quarries											
Sc*:											
Shidler----------	0-11	Silt loam--------	CL, ML	A-4, A-6	0	90-100	90-100	90-100	75-98	30-37	8-13
	11	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Catoosa----------	0-10	Silt loam--------	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	10-31	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sd*:											
Stephenville----	0-17	Fine sandy loam	SM	A-2	0	100	98-100	90-100	15-35	---	NP
	17-30	Fine sandy loam, sandy clay loam.	SC, CL	A-4, A-6	0	100	98-100	90-100	36-65	25-37	7-16
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---
Darnell----------	0-6	Fine sandy loam	SM, SC, ML, CL	A-4	0-5	90-100	90-100	85-100	36-60	<30	NP-10
	6-16	Fine sandy loam, loam.	SM, SC, ML, CL	A-4	0-8	70-100	70-100	60-100	36-60	<30	NP-10
	16	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ts*:											
Talihina---------	0-7	Silty clay loam	CL	A-6, A-7	0-15	87-100	87-100	85-100	70-98	37-50	15-26
	7-17	Silty clay, clay, clay loam.	CH, CL	A-6, A-7	0-15	87-100	87-100	85-100	70-98	37-50	15-26
	17	Weathered bedrock	---	---	---	---	---	---	---	---	---
Shale outcrop.											
Vb, Vc------------ Verdigris	0-28	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	28-60	Silt loam, silty clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Wo---------------- Woodson	0-11	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	11-60	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	90-100	50-65	30-45
Za, Zb------------ Zaar	0-14	Silty clay--------	CH, CL	A-7	0	100	100	95-100	90-100	45-70	20-40
	14-60	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Ba, Bb, Bc-------- Bates	0-15	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low--------	0.28	4	6	1-4
	15-27	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low--------	0.28			
	27	---	---	---	---	---	---	-----------	----			
Bf*, Bg*:												
Bates------------	0-15	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low--------	0.28	4	6	1-4
	15-27	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low--------	0.28			
	27	---	---	---	---	---	---	-----------	----			
Collinsville-----	0-11	5-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low--------	0.20	2	3	1-2
	11-17	5-20	1.30-1.65	2.0-6.0	0.09-0.13	5.1-6.5	<2	Low--------	0.20			
	17	---	---	---	---	---	---	-----------	----			
Bu*:												
Bates------------	0-15	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low--------	0.28	4	6	1-4
	15-24	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low--------	0.28			
	24	---	---	---	---	---	---	-----------	----			
Urban land.												
Ca---------------- Catoosa	0-10	10-20	1.30-1.50	0.6-2.0	0.15-0.24	5.6-6.5	<2	Low--------	0.32	3	6	1-2
	10-31	27-35	1.45-1.75	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	31	---	---	---	---	---	---	-----------	----			
Db, Dc------------ Dennis	0-13	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low--------	0.37	4	6	1-3
	13-19	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	19-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High-------	0.37			
Eb, Ec, Ef-------- Eram	0-11	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	11-32	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	32	---	---	---	---	---	---	-----------	----			
Et*:												
Eram-------------	0-11	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	11-32	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	32	---	---	---	---	---	---	-----------	----			
Talihina---------	0-7	35-40	1.30-1.60	0.06-0.2	0.15-0.19	5.1-7.8	<2	High-------	0.32	2	6	1-3
	7-17	35-55	1.25-1.45	0.06-0.2	0.12-0.18	5.1-7.8	<2	High-------	0.37			
	17	---	---	---	---	---	---	-----------	----			
Eu*:												
Eram-------------	0-11	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	11-30	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	30	---	---	---	---	---	---	-----------	----			
Urban land.												
Ka---------------- Kenoma	0-12	18-29	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.43	4	6	2-4
	12-60	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High-------	0.32			
La---------------- Lanton	0-12	27-35	1.30-1.40	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low--------	0.32	5	7	2-4
	12-32	24-35	1.35-1.50	0.2-0.6	0.17-0.22	6.1-7.3	<2	Low--------	0.43			
	32-60	35-45	1.45-1.55	0.06-0.6	0.12-0.18	6.1-7.3	<2	Moderate	0.32			
Ma---------------- Mason	0-18	20-30	1.30-1.60	0.6-2.0	0.16-0.20	5.1-7.3	<2	Low--------	0.32	5	6	1-3
	18-60	20-35	1.40-1.70	0.2-0.6	0.16-0.20	4.5-7.8	<2	Moderate	0.32			
Nd*:												
Niotaze----------	0-11	5-20	1.35-1.45	0.6-6.0	0.06-0.11	5.1-6.0	<2	Low--------	0.20	3	8	<1
	11-32	35-55	1.35-1.45	0.06-0.2	0.10-0.20	4.5-7.3	<2	High-------	0.28			
	32	---	---	---	---	---	---	-----------	----			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors		Wind erodi- bility group	Organic matter
									K	T		
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
Nd*:												
Darnell---------	0-6	10-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-7.3	<2	Low--------	0.24	2	3	<1
	6-16	10-25	1.40-1.70	2.0-6.0	0.12-0.16	5.1-7.3	<2	Low--------	0.32			
	16	---	---	---	---	---	---	----------	----			
Oa*. Oil wasteland												
Od*:												
Olpe------------	0-16	15-30	1.20-1.30	0.6-2.0	0.06-0.13	5.1-6.5	<2	Low--------	0.24	3	8	1-3
	16-21	27-45	1.30-1.40	0.2-0.6	0.04-0.10	5.1-6.5	<2	Low--------	0.24			
	21-60	35-50	1.35-1.45	0.06-0.2	0.04-0.10	5.6-7.8	<2	Moderate	0.24			
Dennis----------	0-13	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low--------	0.37	4	6	1-3
	13-19	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	19-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
Or*. Orthents												
Os--------------- Osage	0-15	40-50	1.40-1.60	<0.06	0.12-0.14	5.1-7.3	<2	Very high	0.28	5	4	1-4
	15-60	40-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Pa--------------- Parsons	0-12	15-25	1.30-1.50	0.6-2.0	0.16-0.24	5.1-6.5	<2	Low--------	0.43	4	6	.5-1
	12-60	35-60	1.40-1.70	<0.06	0.14-0.22	5.1-7.8	<2	High------	0.43			
Qu*. Quarries												
Sc*:												
Shidler---------	0-11	18-25	1.30-1.50	0.6-2.0	0.16-0.24	5.6-8.4	<2	Low--------	0.32	1	4L	1-3
	11	---	---	---	---	---	---	----------	----			
Catoosa---------	0-10	10-20	1.30-1.50	0.6-2.0	0.15-0.24	5.6-6.5	<2	Low--------	0.32	3	6	1-2
	10-31	27-35	1.45-1.75	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	31	---	---	---	---	---	---	----------	----			
Sd*:												
Stephenville----	0-17	5-15	1.35-1.50	2.0-6.0	0.07-0.11	5.1-7.3	<2	Low--------	0.24	4	3	<1
	17-30	18-35	1.50-1.70	0.6-2.0	0.11-0.17	5.1-6.5	<2	Low--------	0.32			
	30	---	---	---	---	---	---	----------	----			
Darnell---------	0-6	10-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-7.3	<2	Low--------	0.24	2	3	<1
	6-16	10-25	1.40-1.70	2.0-6.0	0.12-0.16	5.1-7.3	<2	Low--------	0.32			
	16	---	---	---	---	---	---	----------	----			
Ts*:												
Talihina--------	0-7	35-40	1.30-1.60	0.06-0.2	0.15-0.19	5.1-7.8	<2	High------	0.32	2	6	1-3
	7-17	35-55	1.25-1.45	0.06-0.2	0.12-0.18	5.1-7.8	<2	High------	0.37			
	17	---	---	---	---	---	---	----------	----			
Shale outcrop.												
Vb, Vc----------- Verdigris	0-28	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
	28-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Wo--------------- Woodson	0-11	18-30	1.25-1.45	0.2-0.6	0.22-0.24	5.6-6.5	<2	Low--------	0.43	4	6	1-4
	11-60	40-60	1.30-1.45	<0.06	0.12-0.15	5.6-7.3	<2	High------	0.32			
Za, Zb----------- Zaar	0-14	35-60	1.20-1.30	<0.06	0.12-0.21	5.6-7.3	<2	High------	0.28	5	4	2-4
	14-60	40-60	1.35-1.50	<0.06	0.11-0.18	6.1-8.4	<2	High------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ba, Bb, Bc-------- Bates	B	None--------	---	---	>6.0	---	---	20-40	Soft	---	Low------	Moderate.
Bf*, Bg*:												
Bates------------	B	None--------	---	---	>6.0	---	---	20-40	Soft	---	Low------	Moderate.
Collinsville-----	C	None--------	---	---	>6.0	---	---	4-20	Hard	---	Low------	Moderate.
Bu*:												
Bates------------	B	None--------	---	---	>6.0	---	---	20-40	Soft	---	Low------	Moderate.
Urban land.												
Ca---------------- Catoosa	B	None--------	---	---	>6.0	---	---	20-40	Hard	---	Moderate	Moderate.
Db, Dc------------ Dennis	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	---	High-----	Moderate.
Eb, Ec, Ef-------- Eram	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	---	High-----	Moderate.
Et*:												
Eram-------------	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	---	High-----	Moderate.
Talihina---------	D	None--------	---	---	0.5-2.0	Perched	Nov-Apr	10-20	Soft	---	High-----	Moderate.
Eu*:												
Eram-------------	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	---	High-----	Moderate.
Urban land.												
Ka---------------- Kenoma	D	None--------	---	---	>6.0	---	---	>60	---	---	High-----	Moderate.
La---------------- Lanton	D	Occasional	Very brief	Jan-May	1.0-2.0	Apparent	Dec-May	>60	---	---	High-----	Low.
Ma---------------- Mason	B	Rare--------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate.
Nd*:												
Niotaze----------	C	None--------	---	---	1.0-2.0	Perched	Nov-Jun	20-40	Soft	---	High-----	Moderate.
Darnell----------	C	None--------	---	---	>6.0	---	---	10-20	Soft	---	Low------	Moderate.
Oa*. Oil wasteland												

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In				
Od*:												
Olpe-------------	C	None--------	---	---	>6.0	---	---	>60	---	---	High-----	Moderate.
Dennis-----------	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	---	High-----	Moderate.
Or*. Orthents												
Os---------------- Osage	D	Occasional	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	---	High-----	Moderate.
Pa---------------- Parsons	D	None--------	---	---	0.5-1.5	Perched	Dec-Apr	>60	---	---	High-----	Moderate.
Qu*. Quarries												
Sc*:												
Shidler----------	D	None--------	---	---	>6.0	---	---	4-20	Hard	---	Moderate	Low.
Catoosa----------	B	None--------	---	---	>6.0	---	---	20-40	Hard	---	Moderate	Moderate.
Sd*:												
Stephenville-----	B	None--------	---	---	>6.0	---	---	20-40	Soft	---	Moderate	Moderate.
Darnell----------	C	None--------	---	---	>6.0	---	---	10-20	Soft	---	Low------	Moderate.
Ts*:												
Talihina---------	D	None--------	---	---	0.5-2.0	Perched	Nov-Apr	10-20	Soft	---	High-----	Moderate.
Shale outcrop.												
Vb---------------- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	---	Low------	Low.
Vc---------------- Verdigris	B	Frequent----	Very brief	Dec-Jun	>6.0	---	---	>60	---	---	Low------	Low.
Wo---------------- Woodson	D	None--------	---	---	0.5-2.0	Perched	Dec-Apr	>60	---	---	High-----	Moderate.
Za, Zb------------ Zaar	D	None--------	---	---	1.0-2.0	Perched	Dec-Apr	>60	---	---	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--ENGINEERING INDEX TEST DATA

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution*							Liquid limit	Plasticity index	Moisture density**	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Moisture density	Optimum moisture
										Pct		Lb/ft3	Pct
Collinsville fine sandy loam: (S76KS-125-002)													
C--------11 to 18	A-4(00)	SM	100	100	94	47	9	0	0	31	5	102	15
Eram silty clay loam: (S77KS-125-011)													
A1--------0 to 11	A-7-6(19)	CL	100	100	98	89	67	0	0	45	19	99	21
B22t-----17 to 25	A-7-6(25)	CH	100	100	90	80	70	0	0	57	29	98	22
Cr-------32 to 43	A-7-6(27)	CL	100	100	99	94	58	0	0	49	26	107	18

* Grain-size distribution according to AASHTO Designation T 88 72 with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher; (2) the sample is not soaked prior to dispersion; (3) dispersing time is 5 minutes at 7 p.s.i. using an Iowa air tube; and (4) AASHTO T 133 74 is followed except for sample size to obtain SpG for the hydrometer analysis. Results by this procedure commonly differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes.

** Moisture density based on AASHTO Designation T 99 74, Method A, with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher after drying; and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

TABLE 19.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Catoosa	Fine-silty, mixed, thermic Typic Argiudolls
Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
Darnell	Loamy, siliceous, thermic, shallow Udic Ustochrepts
Dennis	Fine, mixed, thermic Aquic Paleudolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Lanton	Fine-silty, mixed, thermic Cumulic Haplaquolls
Mason	Fine-silty, mixed, thermic Typic Argiudolls
Niotaze	Fine, montmorillonitic, thermic Aquic Paleustalfs
Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Orthents	Orthents
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Parsons	Fine, mixed, thermic Mollic Albaqualfs
Shidler	Loamy, mixed, thermic Lithic Haplustolls
Stephenville	Fine-loamy, siliceous, thermic Ultic Haplustalfs
Talihina	Clayey, mixed, thermic, shallow Aquic Hapludolls
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Woodson	Fine, montmorillonitic, thermic Abruptic Argiaquolls
Zaar	Fine, montmorillonitic, thermic Vertic Hapludolls

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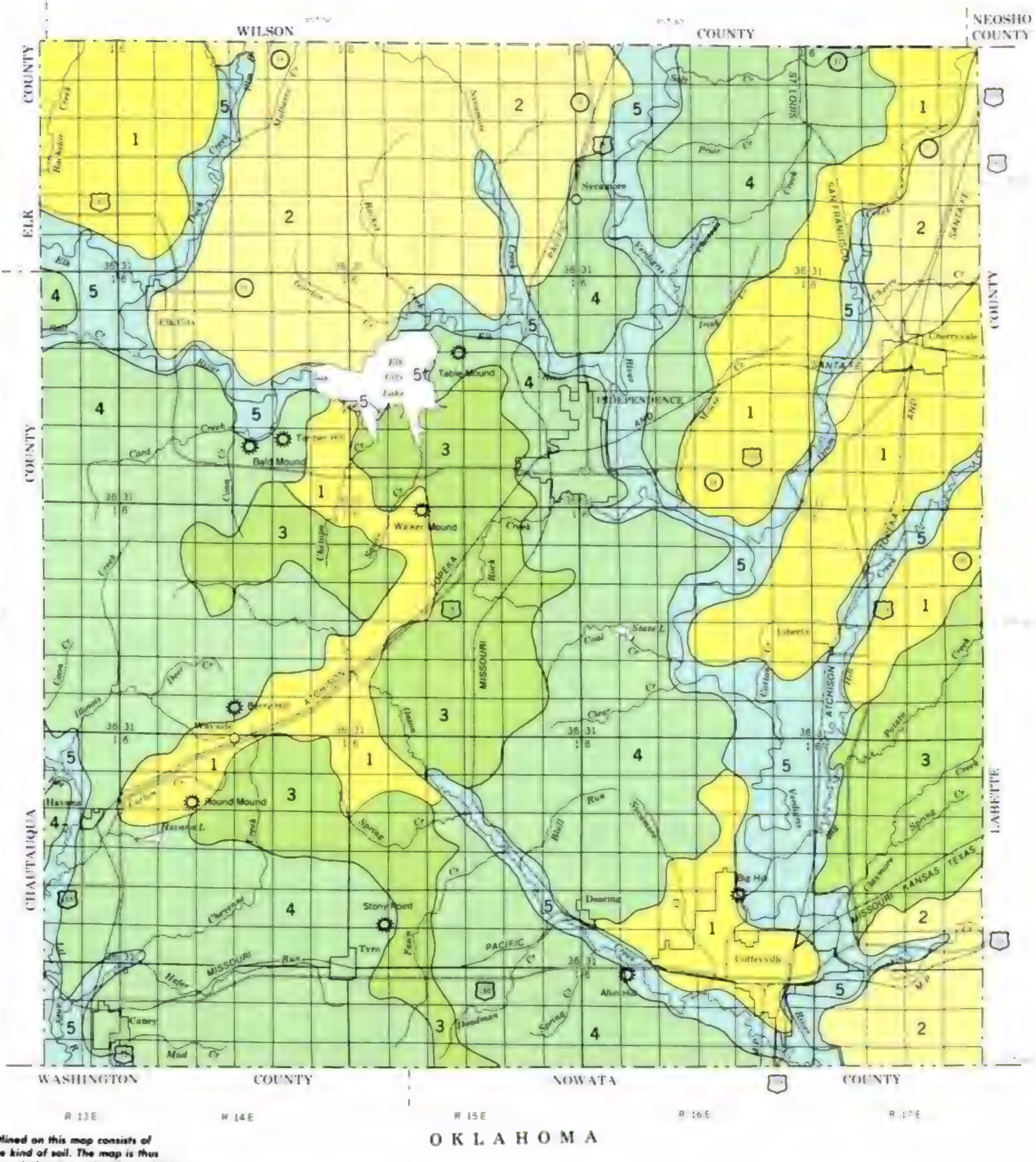
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

MONTGOMERY COUNTY, KANSAS



SOIL LEGEND*

1	Eram-Talihina association: Gently sloping to steep, moderately well drained, silty soils on uplands
2	Catoosa-Kenoma-Zaar association: Nearly level and gently sloping, well drained to somewhat poorly drained, silty and clayey soils on uplands
3	Kenoma-Woodson-Zaar association: Nearly level and gently sloping, moderately well drained and somewhat poorly drained, silty and clayey soils on uplands
4	Bates-Dennis-Collinsville association: Gently sloping to moderately steep, well drained and moderately well drained, loamy and silty soils on uplands
5	Verdigris-Osage-Lanton association: Nearly level, moderately well drained to poorly drained, silty and clayey soils on bottom land

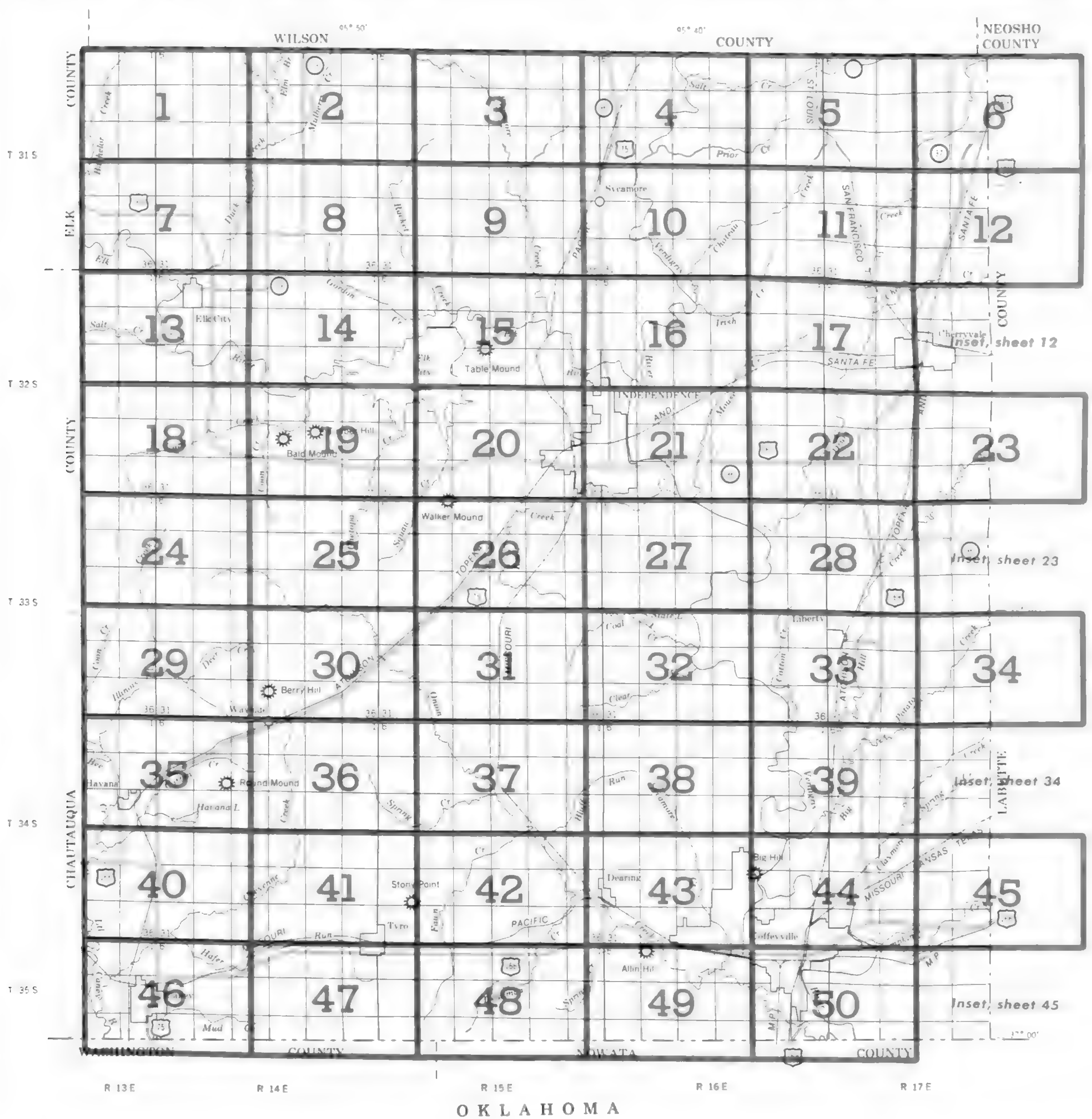
*Texture terms refer to the surface layer of the major soils in each association.

Compiled 1989

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

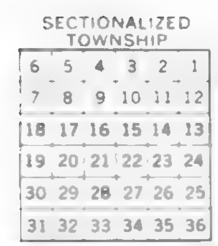
MONTGOMERY COUNTY, KANSAS

Scale 1:190,080

0 1 2 3 4 Miles

Original text from each individual map sheet read:

This map is compiled on 1977 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — Ⓢ

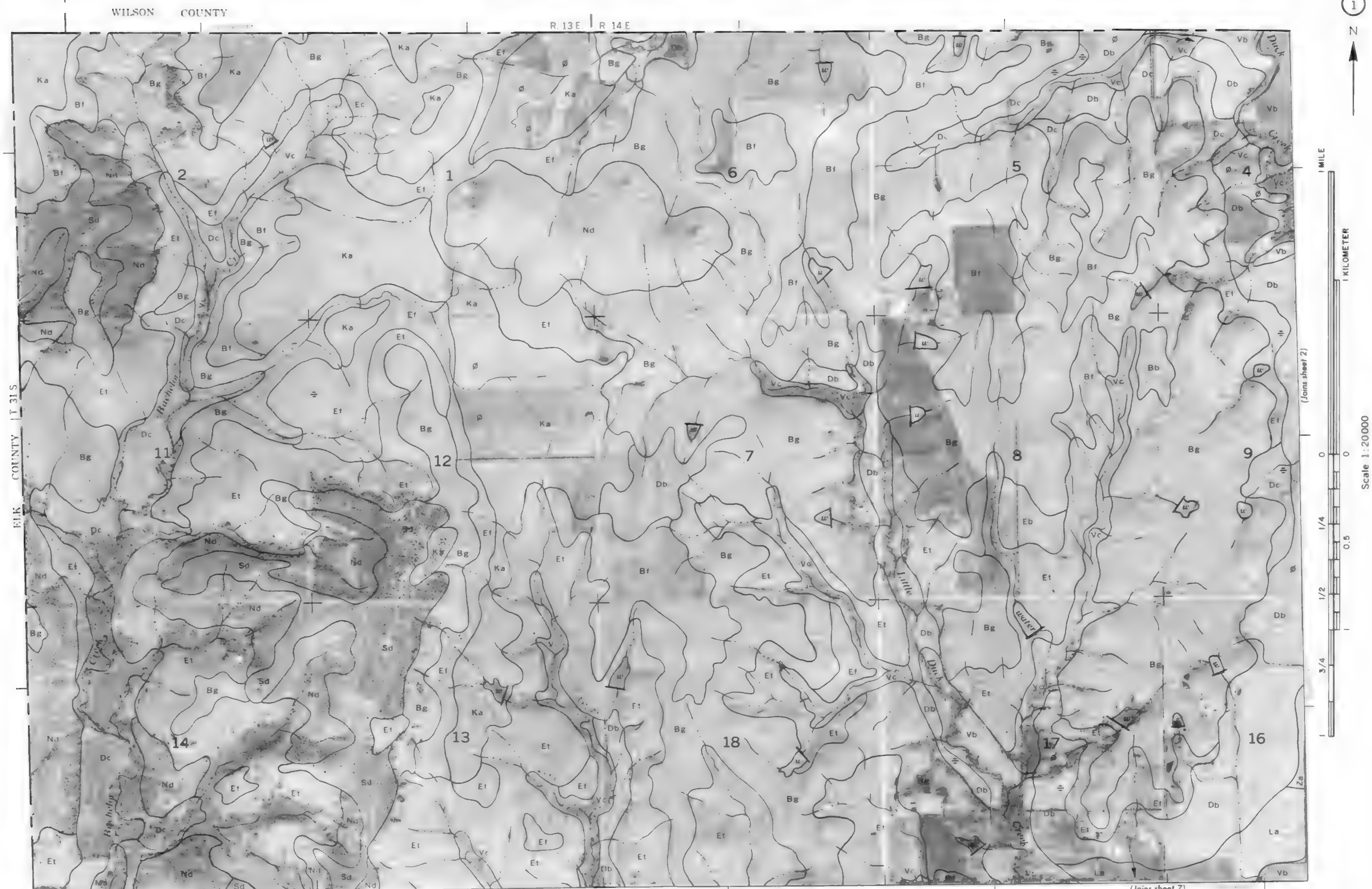
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Borrow area

SOIL LEGEND

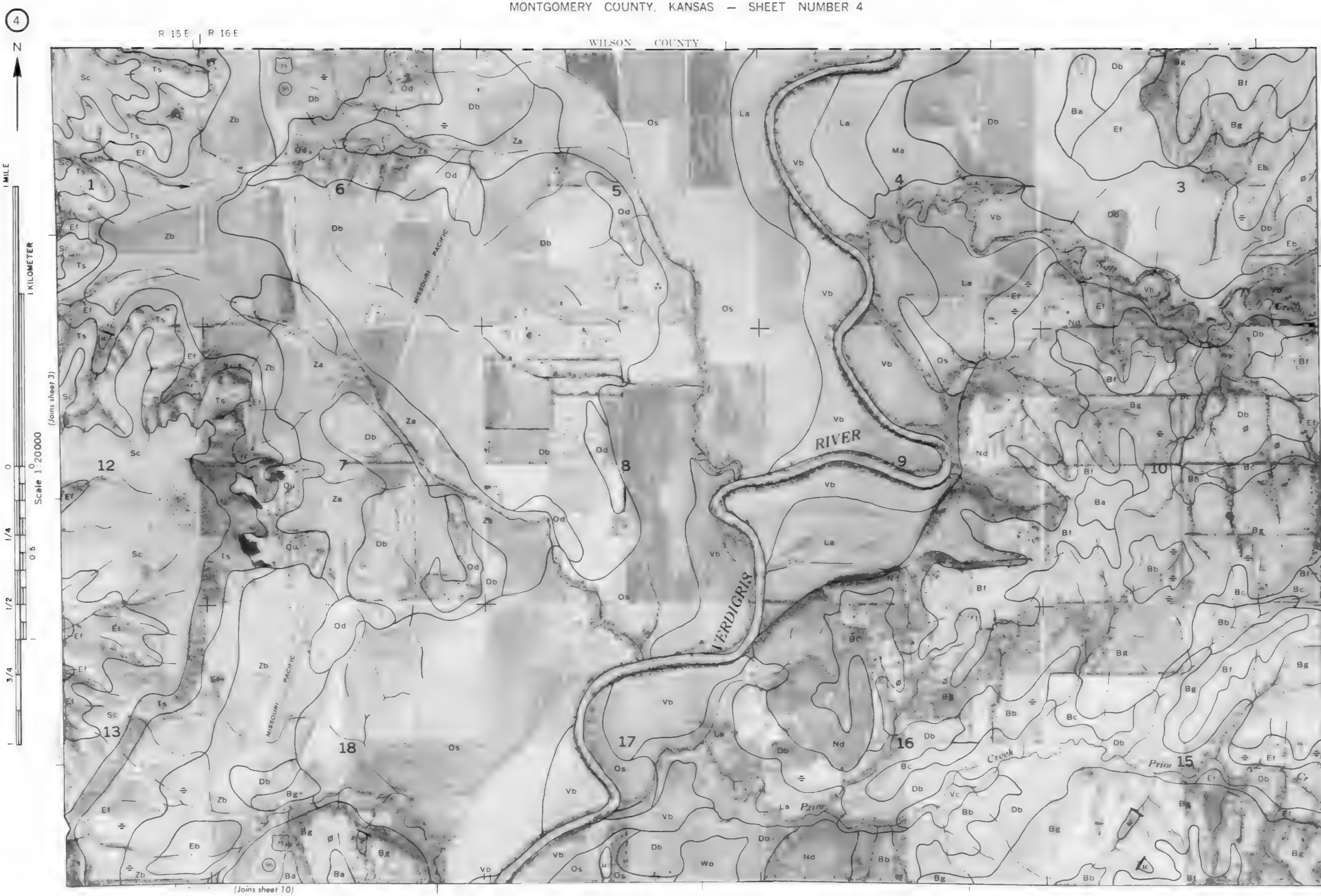
SYMBOL	NAME
Ba	Bates loam, 1 to 3 percent slopes
Bb	Bates loam, 3 to 6 percent slopes
B[illegible]	Bates loam, 2 to 6 percent slopes, eroded
B[illegible]	Bates-Collinsville complex, 1 to 4 percent slopes
Bg	Bates-Collinsville complex, 4 to 20 percent slopes
B[illegible]	Bates-Urban land complex, 2 to 6 percent slopes
[illegible]a	Catoosa silt loam, 0 to 2 percent slopes
Db	Dennis silt loam, 1 to 4 percent slopes
D[illegible]	Dennis silt loam, 4 to 7 percent slopes
[illegible]b	Eram silty clay loam, 1 to 4 percent slopes
[illegible]	Eram silty clay loam, 2 to 6 percent slopes, eroded
[illegible]	Eram silty clay loam, 4 to 7 percent slopes
[illegible]	Eram-Talihina silty clay loams, 6 to 20 percent slopes
[illegible]	Eram-Urban land complex, 2 to 6 percent slopes
[illegible]a	Kenoma silt loam, 0 to 2 percent slopes
[illegible]a	Lanton silty clay loam
Ma	Mason silt loam
Nd	Niotaze-Darnell complex, 8 to 20 percent slopes
[illegible]	Oil wasteland
[illegible]d	Olpe-Dennis complex, 2 to 6 percent slopes
[illegible]	Orthents, clayey
[illegible]	Osage silty clay
P[illegible]	Parsons silt loam
Q	Quarries
[illegible]	Shidler-Catoosa silt loams, 1 to 4 percent slopes
[illegible]c	Stephenville-Darnell fine sandy loams, 1 to 5 percent slopes
[illegible]	Talihina-Shale outcrop complex, 10 to 50 percent slopes
Vb	Verdigris silt loam
[illegible]	Verdigris silt loam, channeled
Wo	Woodson silt loam
[illegible]a	Zaar silty clay, 0 to 1 percent slopes
[illegible]b	Zaar silty clay, 1 to 4 percent slopes

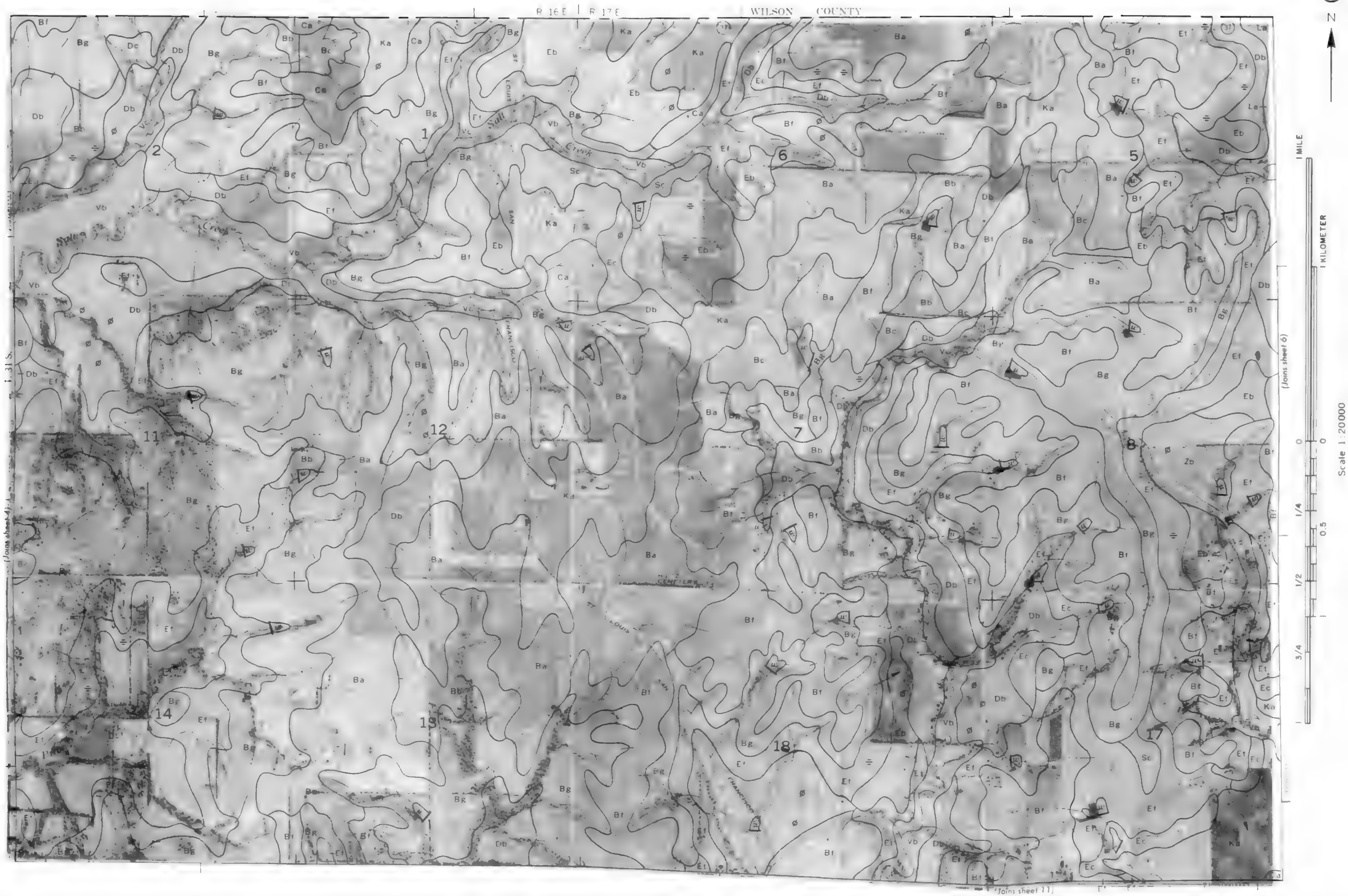
MONTGOMERY COUNTY, KANSAS — SHEET NUMBER 1

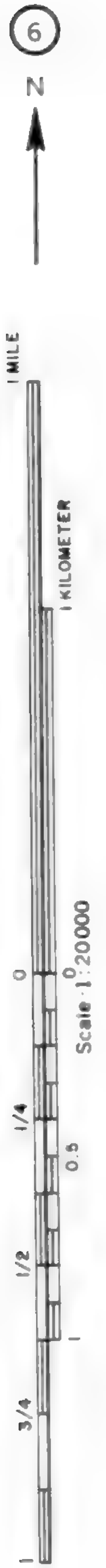


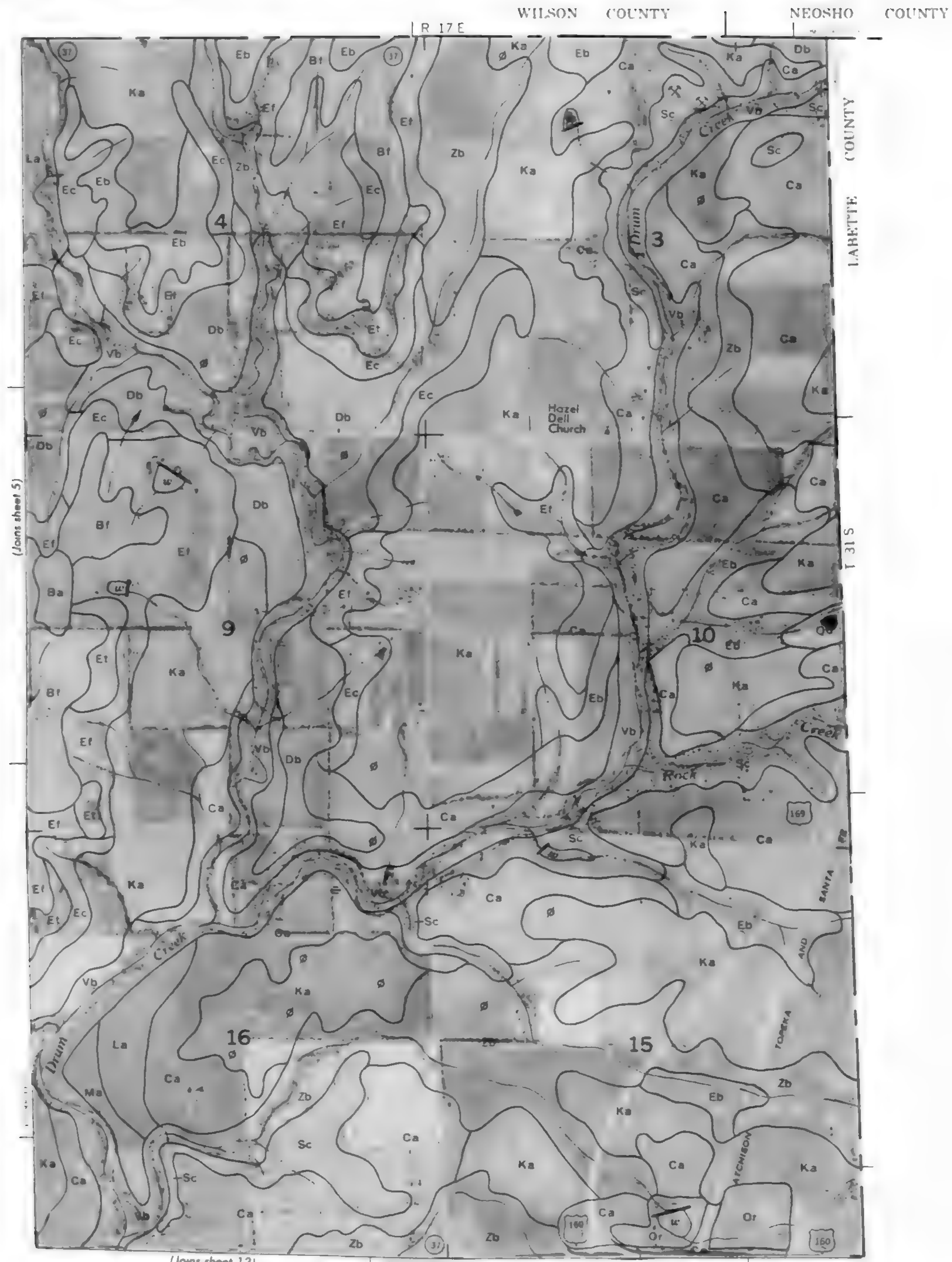

2
N
WILSON COUNTY
R 14 E | R 15 E
T 31 S
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
Elm Branch
Duck Creek
Mulberry Creek
Mulberry
WHITE CEMETERY
FARM RIDGE CEMETERY
39
1
2
3
4
5
6
7
9
10
11
12
13
14
15
18

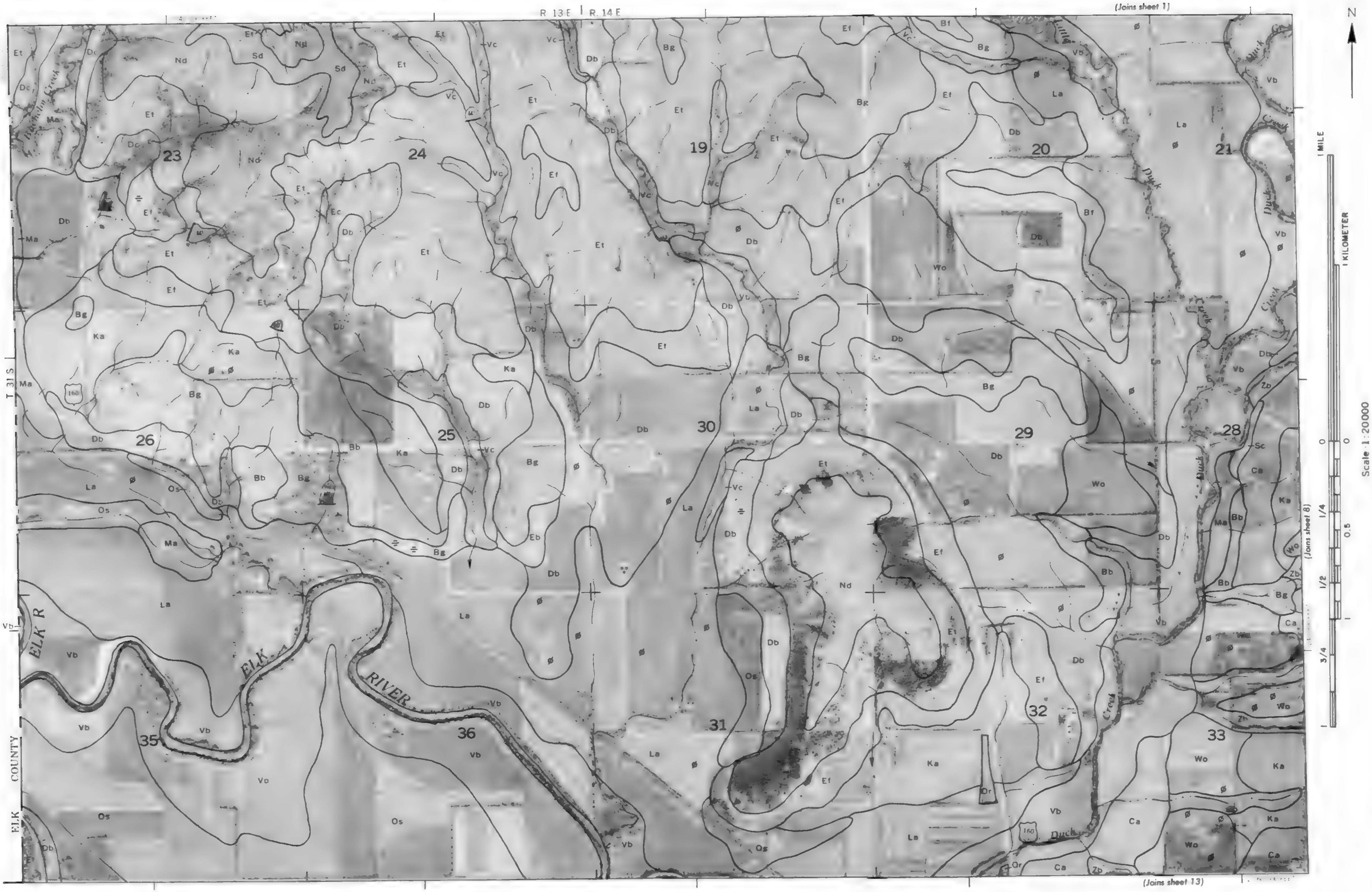

R 15 E
WILSON COUNTY
T 31 S
Sycamore Valley Church
(Joins sheet 4)
(Joins sheet 2)
(Joins sheet 9)
N
1 MILE
1 KILOMETER
Scale 1:20000


4
N
R 15 E
R 16 E
WILSON COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 10)
MISSOURI PACIFIC
VERDIGRIS
RIVER
Prior Creek
Prior Cr

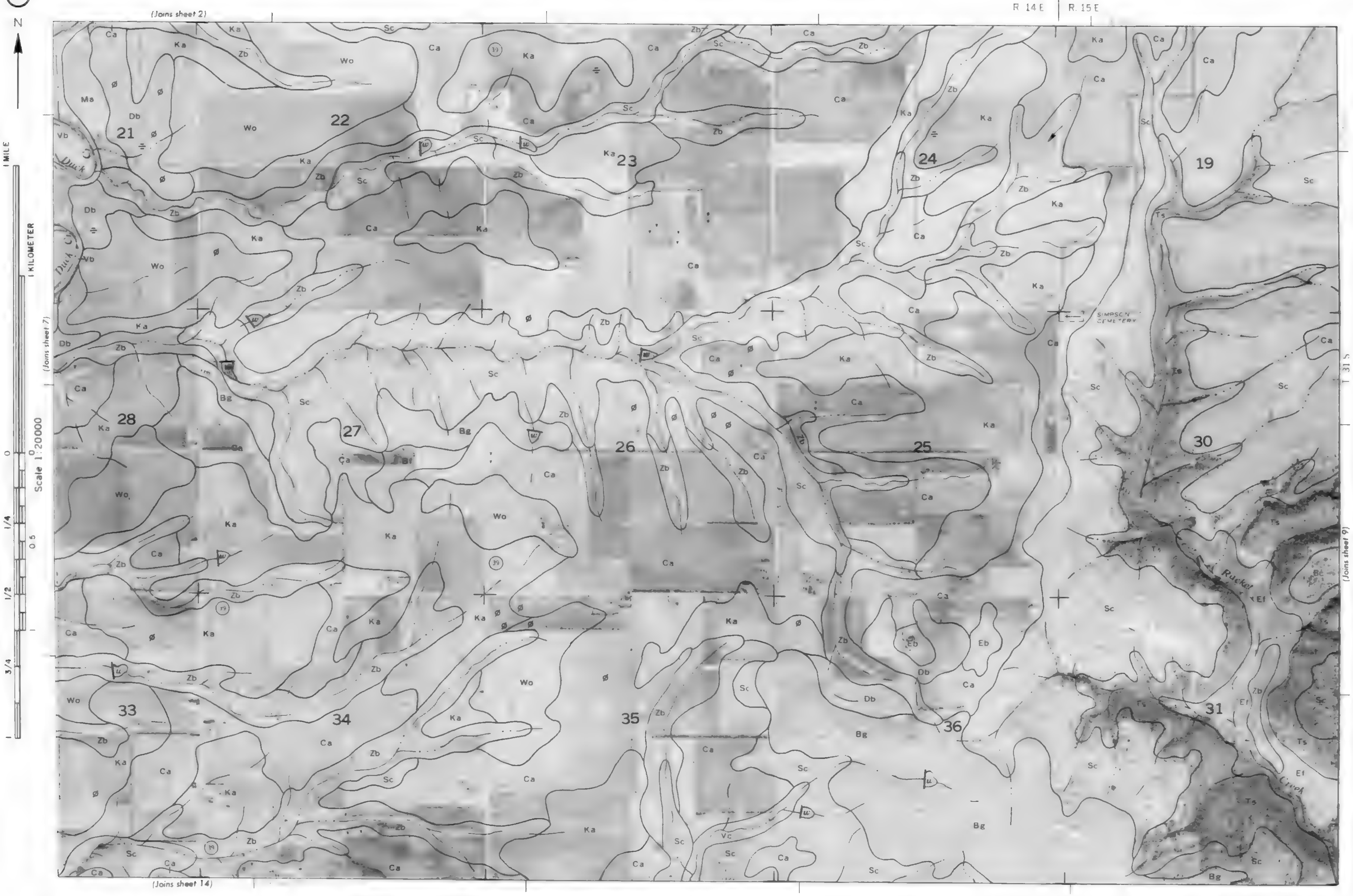

5
N
R 16 E
R 17 E
WILSON COUNTY
T 31 S
Salt Creek
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 11)
CEMETERY
1 MILE
1 KILOMETER
Scale 1:20 000

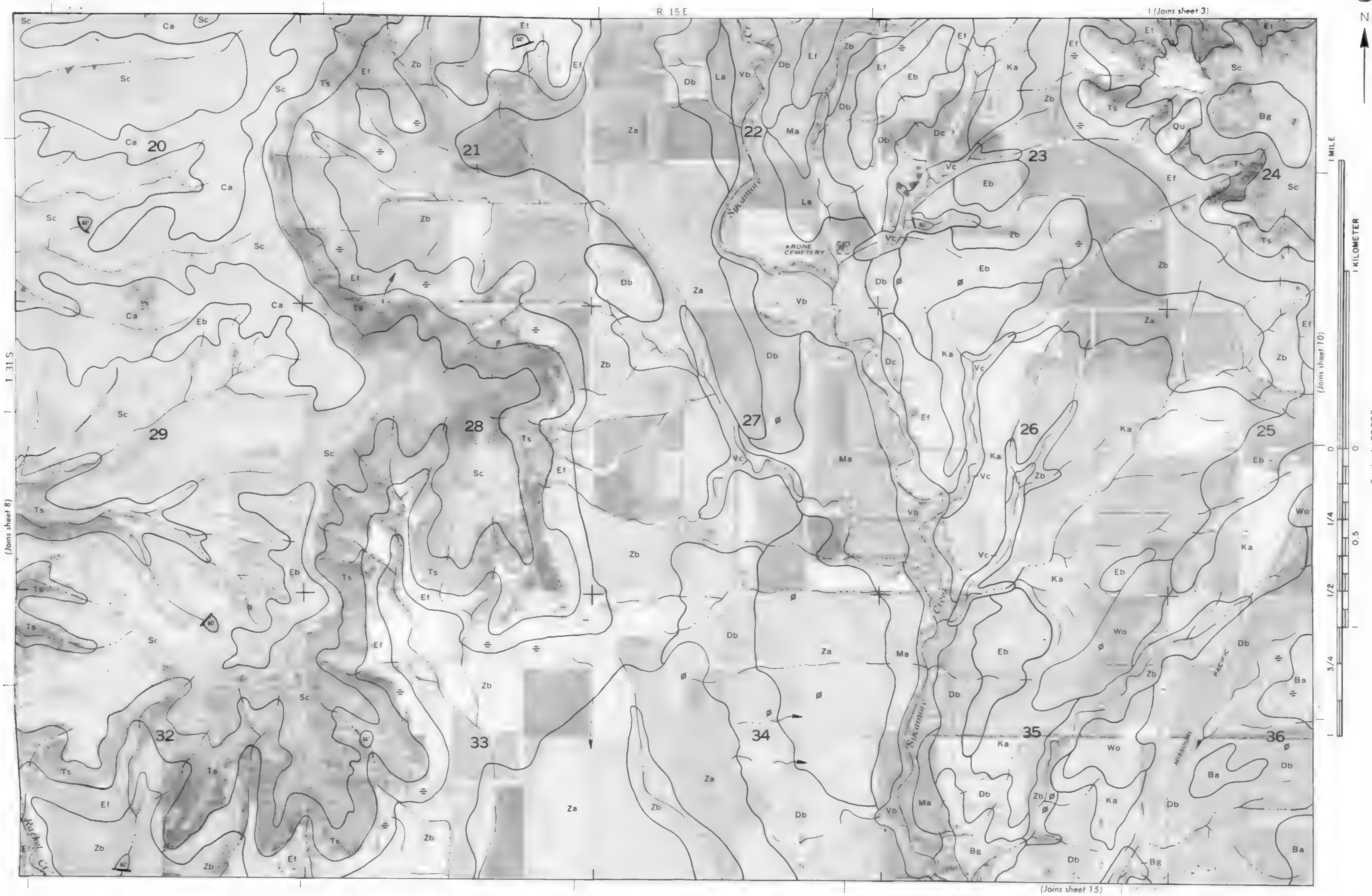

6
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5


WILSON COUNTY
NEOSHO COUNTY
LABETTE COUNTY
R 17 E
T 31 S
(Joins sheet 5)
(Joins sheet 12)
Hazel Dell Church
Drum Creek
Rock Creek
ATCHISON TOPEKA AND SANTA FE
4
3
9
10
16
15


R 13 E
R. 14 E
(Joins sheet 1)
(Joins sheet 8)
(Joins sheet 13)
T 31 S
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
ELK R
ELK RIVER
ELK COUNTY
Duck Creek
Little Duck Creek
Bachelor Creek
160
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

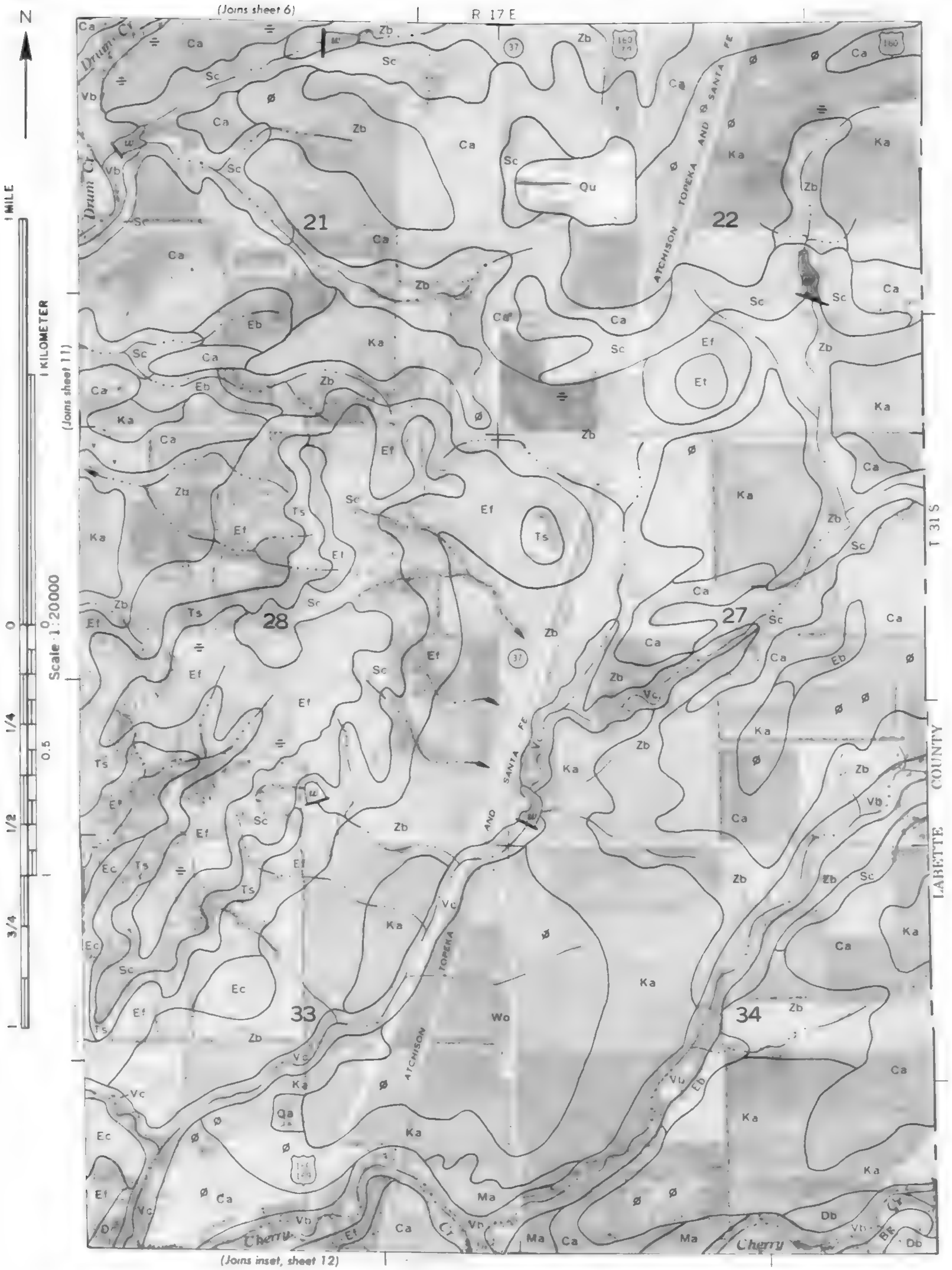
MONTGOMERY COUNTY, KANSAS — SHEET NUMBER 8




9
N
R 15 E
(Joins sheet 3)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 15)
T 31 S
KRONE CEMETERY
Sycamore Cr
Sycamore Creek
Rachel Cr
MISSOURI PACIFIC
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000

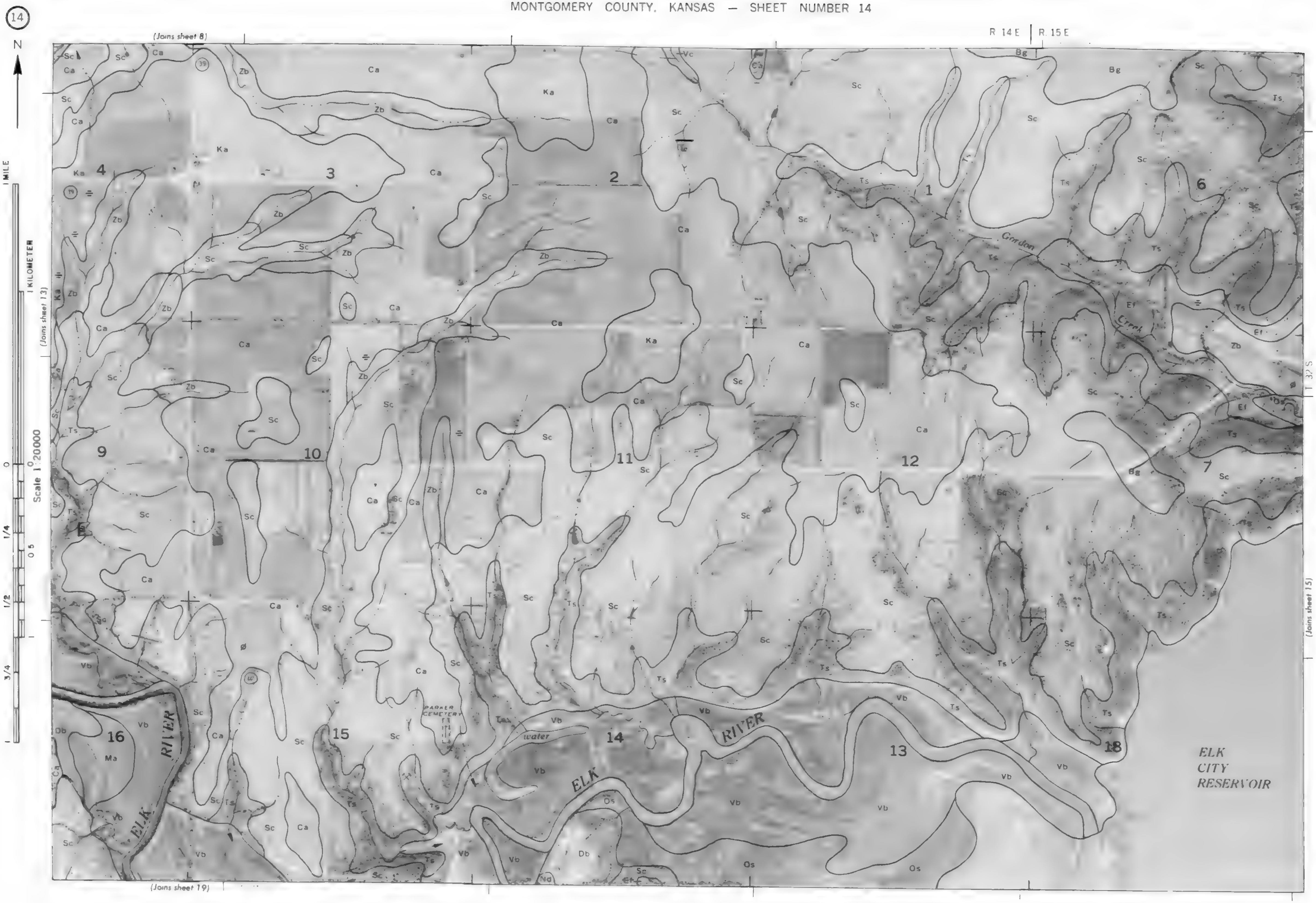

N
R. 15 E.
R. 16 E.
(Joins sheet 4)
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 16)
T. 31 S.
1 MILE
1 KILOMETER
Scale 1:20000
Sycamore
VERDIGRIS RIVER
Choteau Chapel
Choteau Creek
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

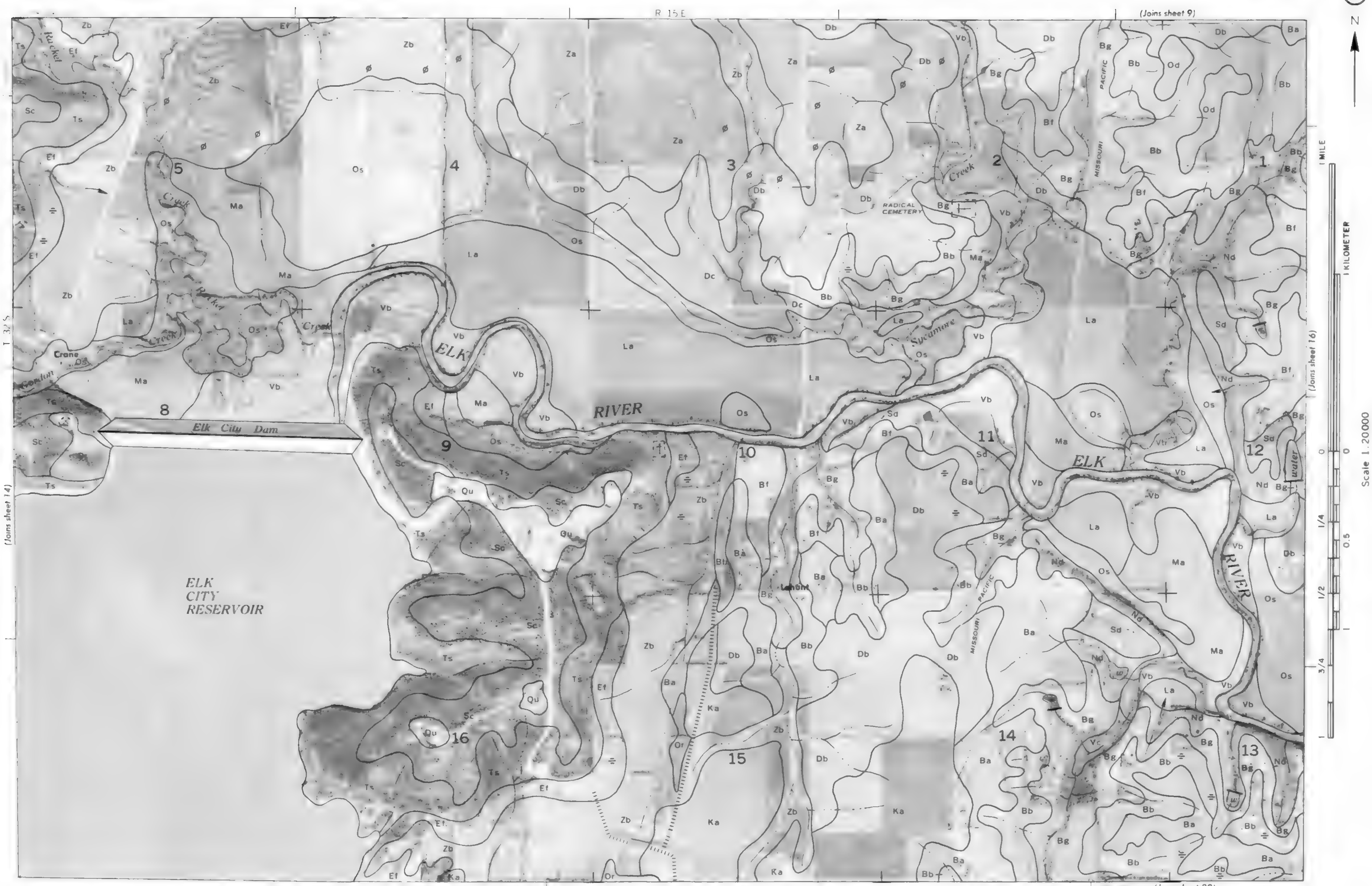

11
R 16 E | R 17 E
(Joins sheet 5)
(Joins sheet 12)
(Joins sheet 17)
(Joins sheet 10)
T 31 S
N
1 MILE
1 KILOMETER
Scale 1:20000
23
24
19
20
26
25
30
29
35
36
31
32
Pleasant Dale Church
ST. LOUIS
SAN FRANCISCO
Choteau
Creek
Drum Creek
Irish Creek
water

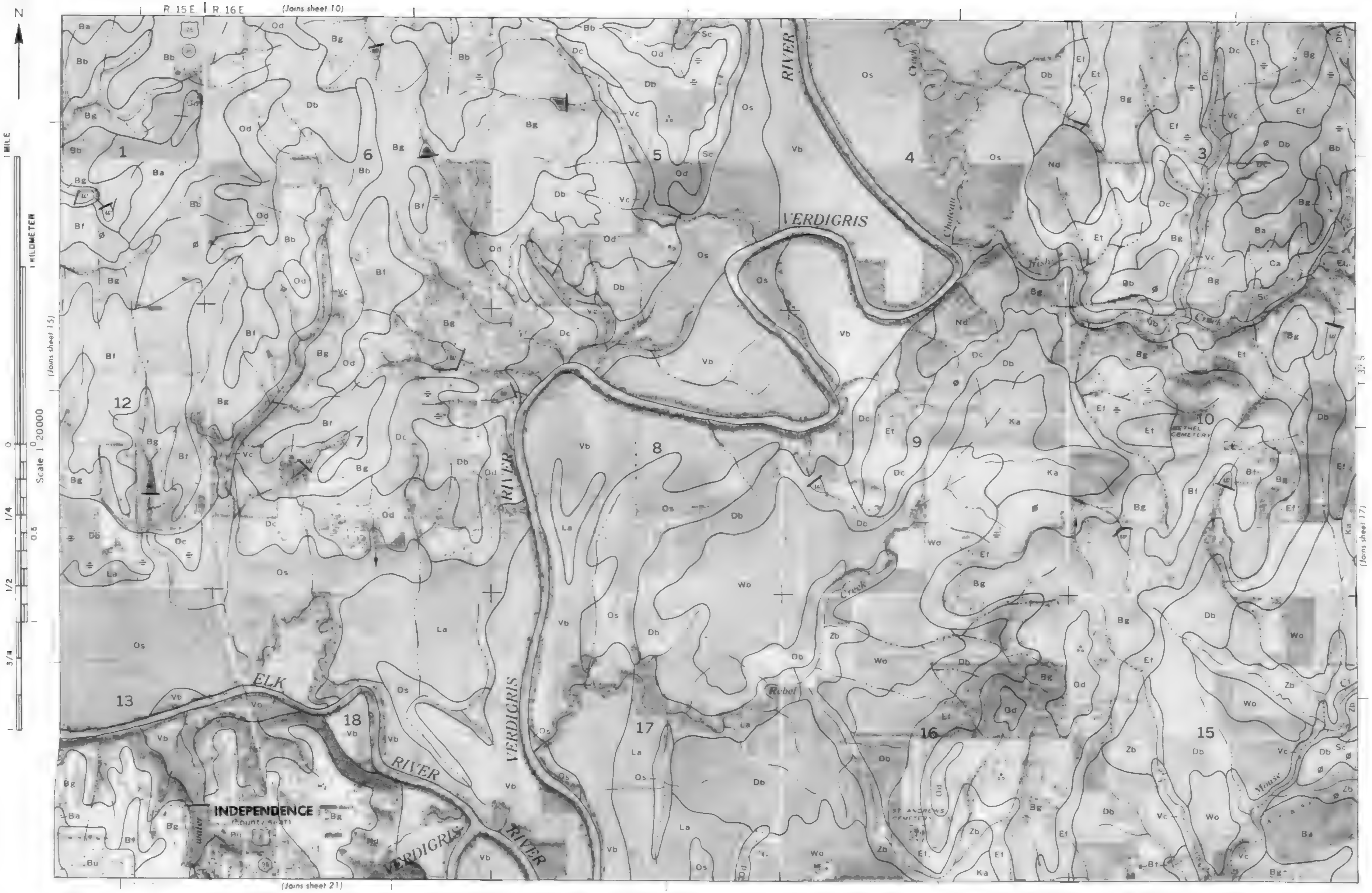

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
(Joins sheet 6)
R 17 E
(Joins sheet 11)
(Joins inset, sheet 12)
T 31 S
LABETTE COUNTY
21
22
27
28
33
34
ATCHISON TOPEKA AND SANTA FE
Drum Cr
Cherry Cr
Ca
Sc
Zb
Ka
Ef
Et
Ts
Eb
Qu
Vc
Vb
Wo
Ec
Ma
Db
Qa


(Joins sheet 12)
R 17 E
(Joins sheet 17)
(Joins sheet 23)
T 32 S
LABETTE COUNTY
4
3
9
10
16
15
CHERRYVALE
FAIRVIEW CEMETERY
ST LOUIS
SAN FRANCISCO
ATCHISON TOPEKA AND SANTA FE
Lake Tanko
water
Cherry Cr
Ka
Wo
Db
Ba
Bc
Bb
Bf
Bg
Zb
Ca
Eb
Ef
Dc
Vc
Vb
Ma
Or

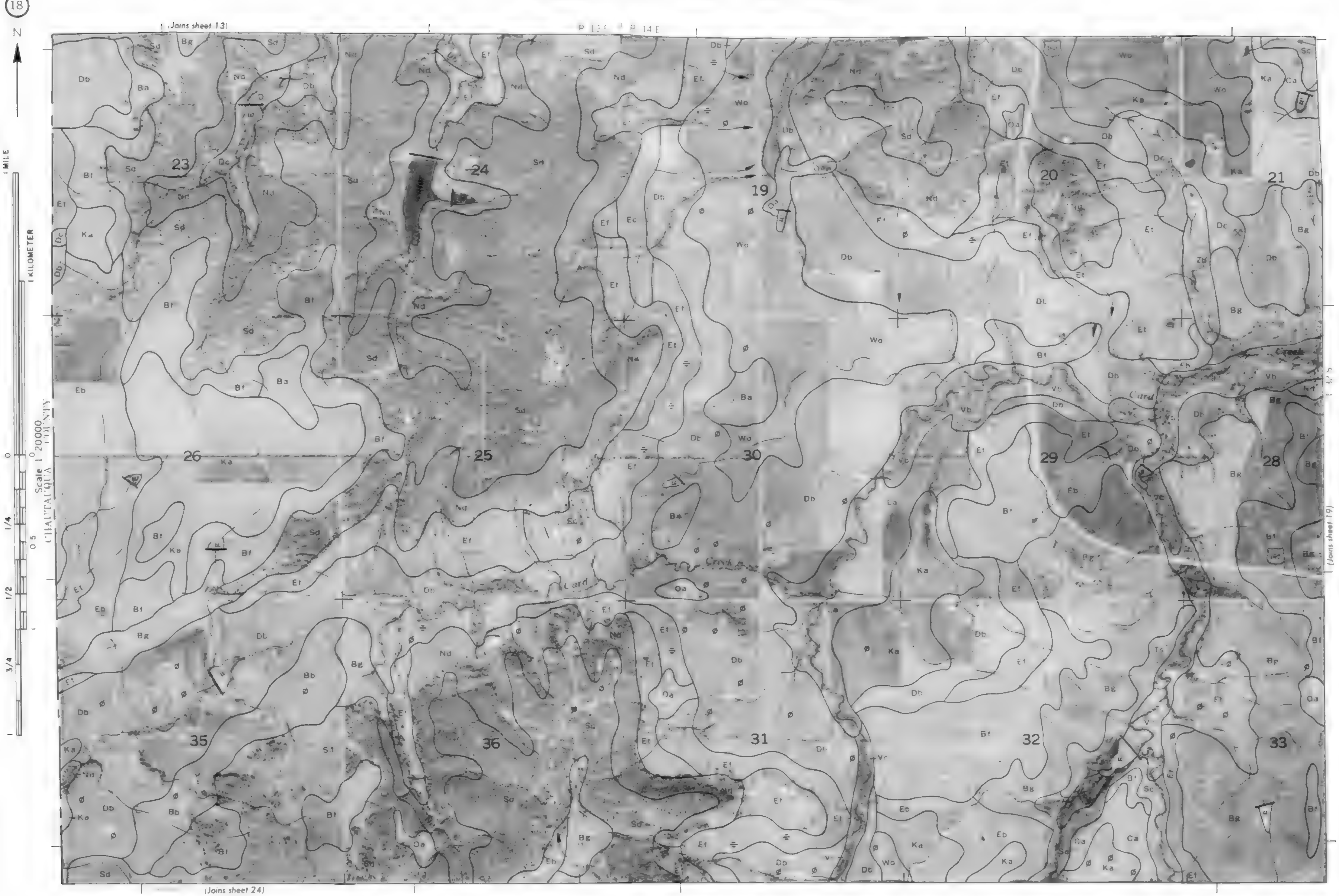
R 13 E | R 14 E
(Joins sheet 7)
(Joins sheet 14)
(Joins sheet 18)
CHAUTAUQUA COUNTY
T 32 S
N
1 MILE
1 KILOMETER
Scale 1:20000
ELK RIVER
Elk City
Duck Creek
Salt Creek

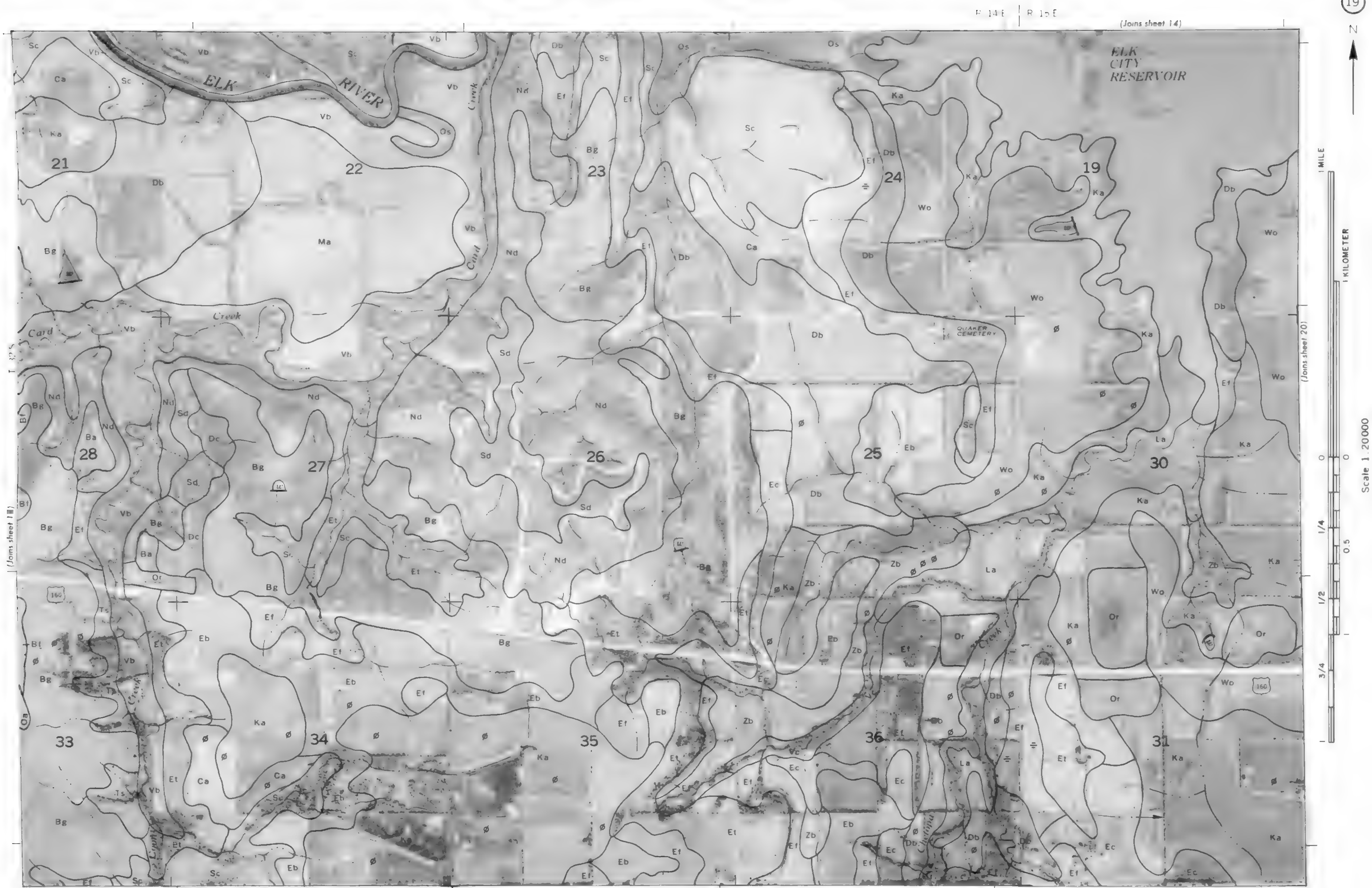

14
N
(Joins sheet 8)
R 14 E
R 15 E
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 19)
T 32 S
1 MILE
1 KILOMETER
Scale 1:20000
Gordon
Creek
ELK
RIVER
ELK CITY RESERVOIR
PARKER CEMETERY
water

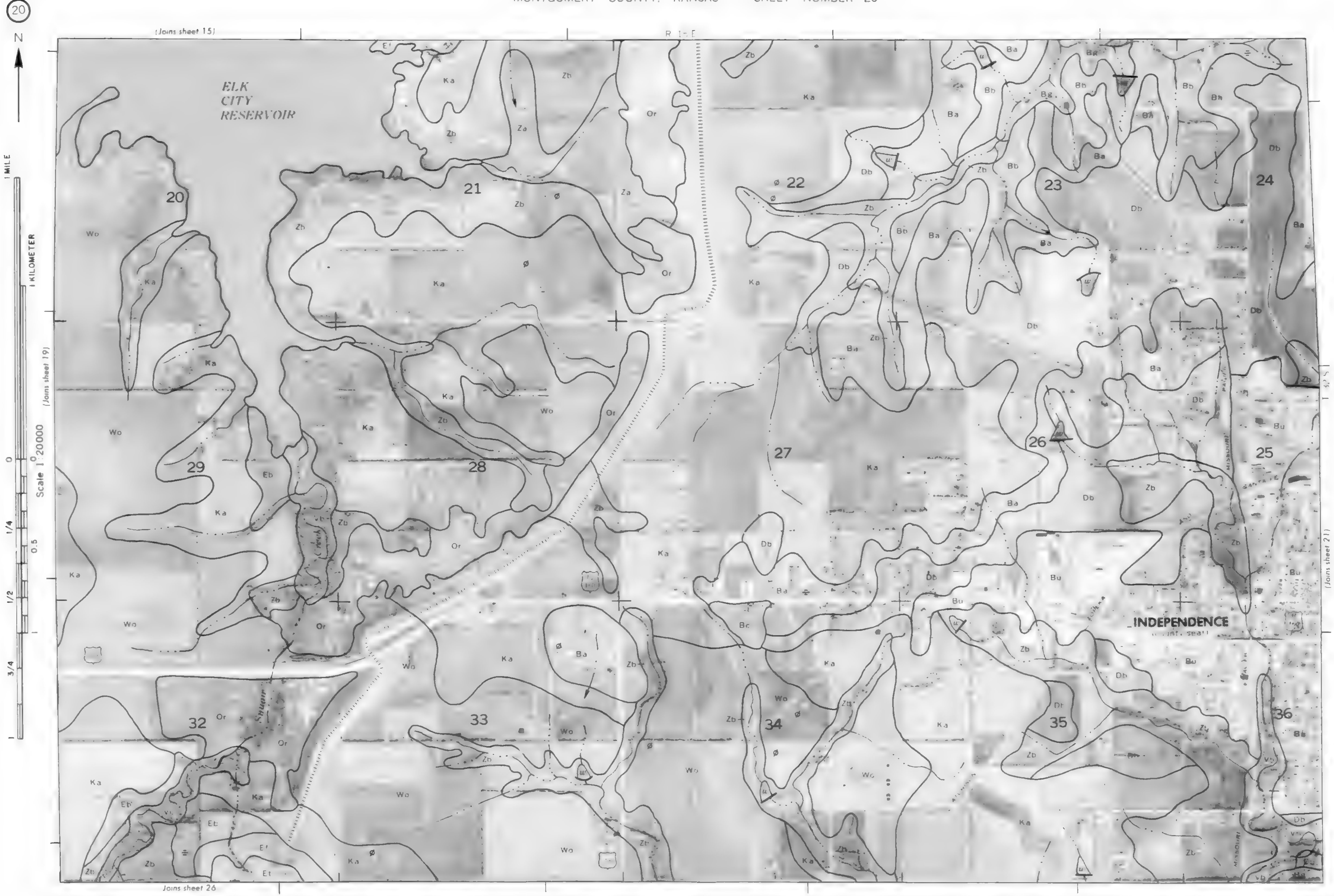

(Joins sheet 9)
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 20)
R 15 E
N
ELK CITY RESERVOIR
Elk City Dam
ELK RIVER
ELK RIVER
RADICAL CEMETERY
Sycamore
Creek
Crane
MISSOURI PACIFIC
MISSOURI PACIFIC
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5


N
R 15 E
R 16 E
(Joins sheet 10)
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 21)
1 MILE
1 KILOMETER
Scale 1:20000
T 32 S
VERDIGRIS
RIVER
ELK
RIVER
Chouteau
Creek
Irish
Creek
Creek
Rebel
Mouse
BETHEL CEMETERY
ST ANDREWS CEMETERY
INDEPENDENCE
(county seat)
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18


(Joins sheet 11)
(Joins sheet 12)
(Joins sheet 16)
(Joins sheet 22)
CHERRYVALE
Cherry
Drum
water
ST. FRANCIS XAVIER CEMETERY
ATCHISON TOPEKA AND SANTA FE
N
1 MILE
1 KILOMETER
Scale 1:20000

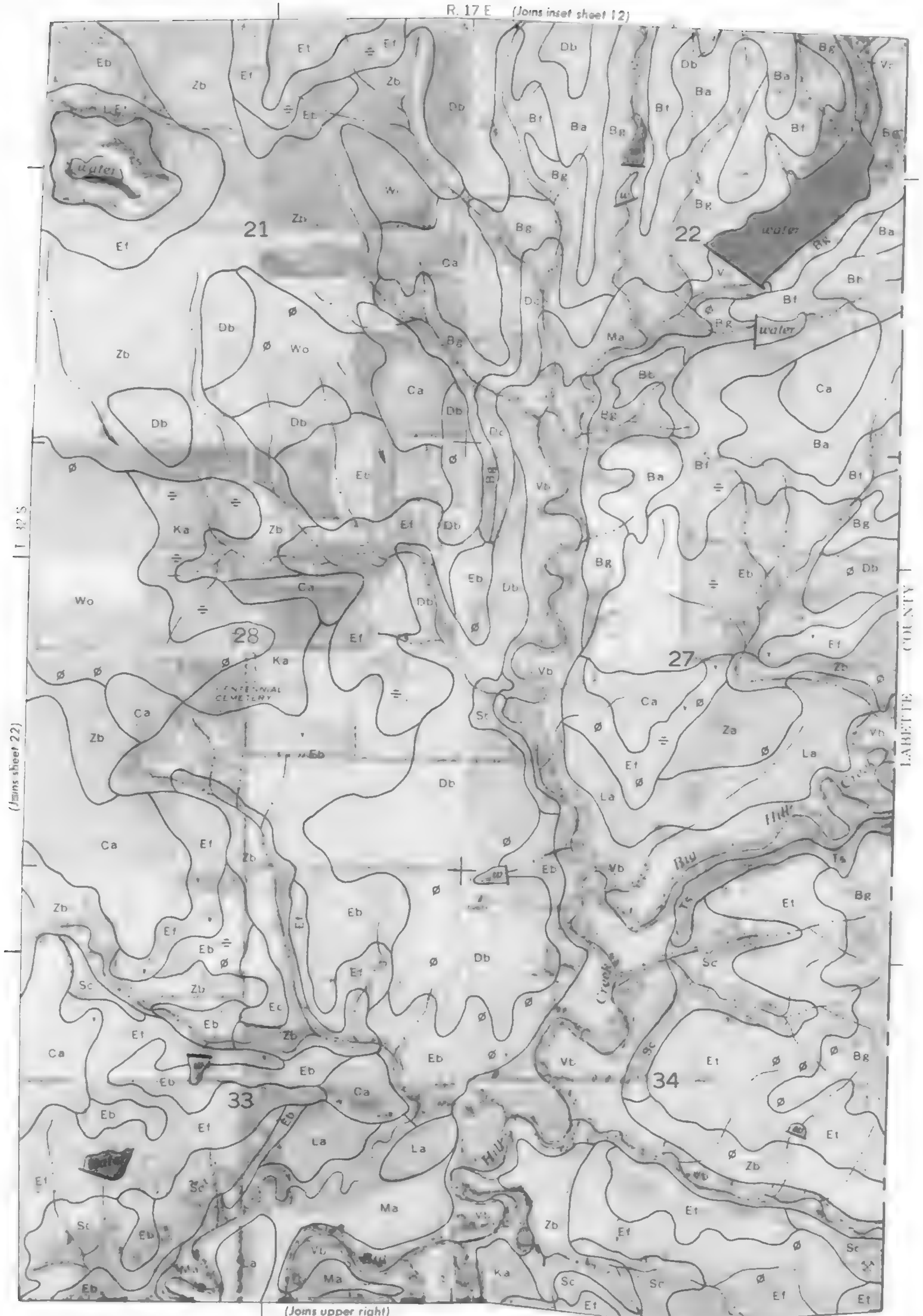

18
N
(Joins sheet 13)
(Joins sheet 24)
(Joins sheet 19)
CHAUTAUQUA COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Card Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

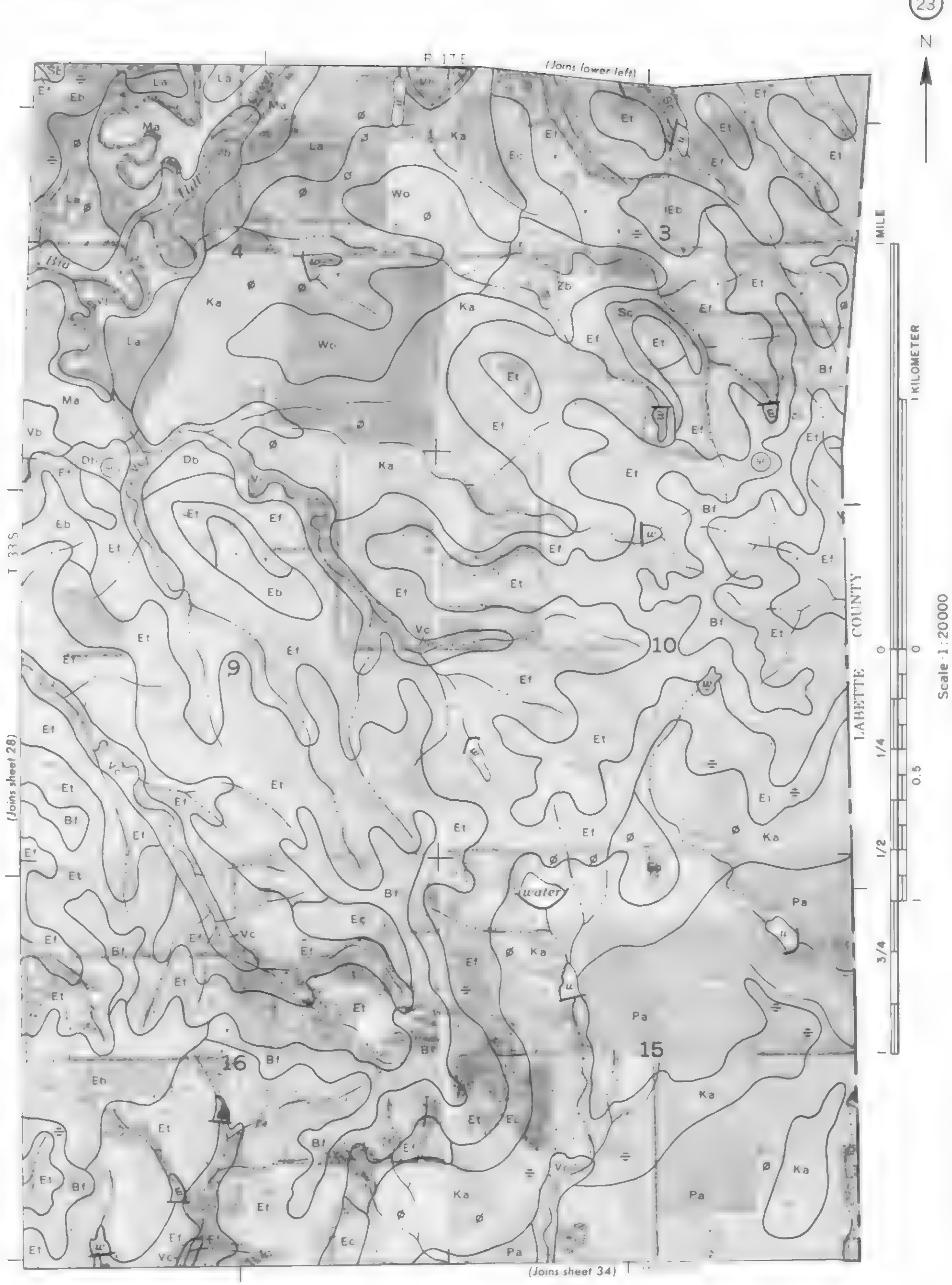

(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 25)
(Joins sheet 18)
R 14 E
R 15 E
N
ELK CITY RESERVOIR
ELK RIVER
Card Creek
Card Creek
Card Creek
Cheyenne Creek
QUAKER CEMETERY
160
21
22
23
24
19
25
26
27
28
30
31
33
34
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

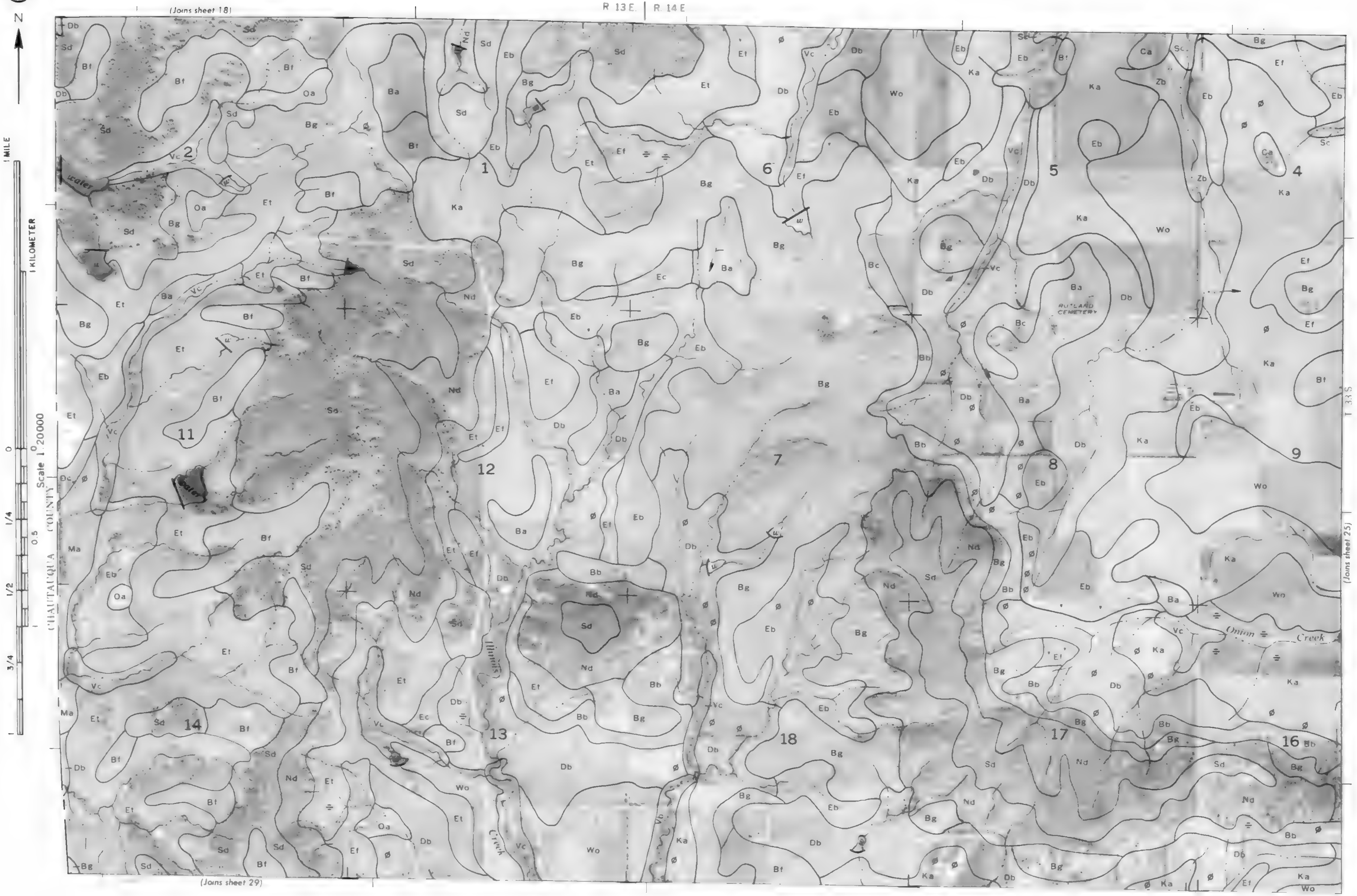

20
N
(Joins sheet 15)
R 15 E
ELK CITY RESERVOIR
(Joins sheet 19)
(Joins sheet 21)
Joins sheet 26
INDEPENDENCE
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
Creek
Squaw
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
Ka
Wo
Zb
Za
Or
Eb
Ba
Bb
Bg
Db
Bu
Bc
Dt


21
N
Joins sheet 16
(Joins sheet 22)
(Joins sheet 27)
(Joins sheet 20)
VERDIGRIS RIVER
INDEPENDENCE
(county seat)
Independence Junior College
MOUNT HOPE CEMETERY
PRATT CEMETERY
ATCHISON TOPEKA AND SANTA FE
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36


N
(Joins sheet 17)
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 28)
R. 16 E.
R. 17 E.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Drum Creek
HARMONY CEMETERY
ATCHISON TOPEKA AND SANTA FE
19
20
23
24
25
26
29
30
31
32
35
36

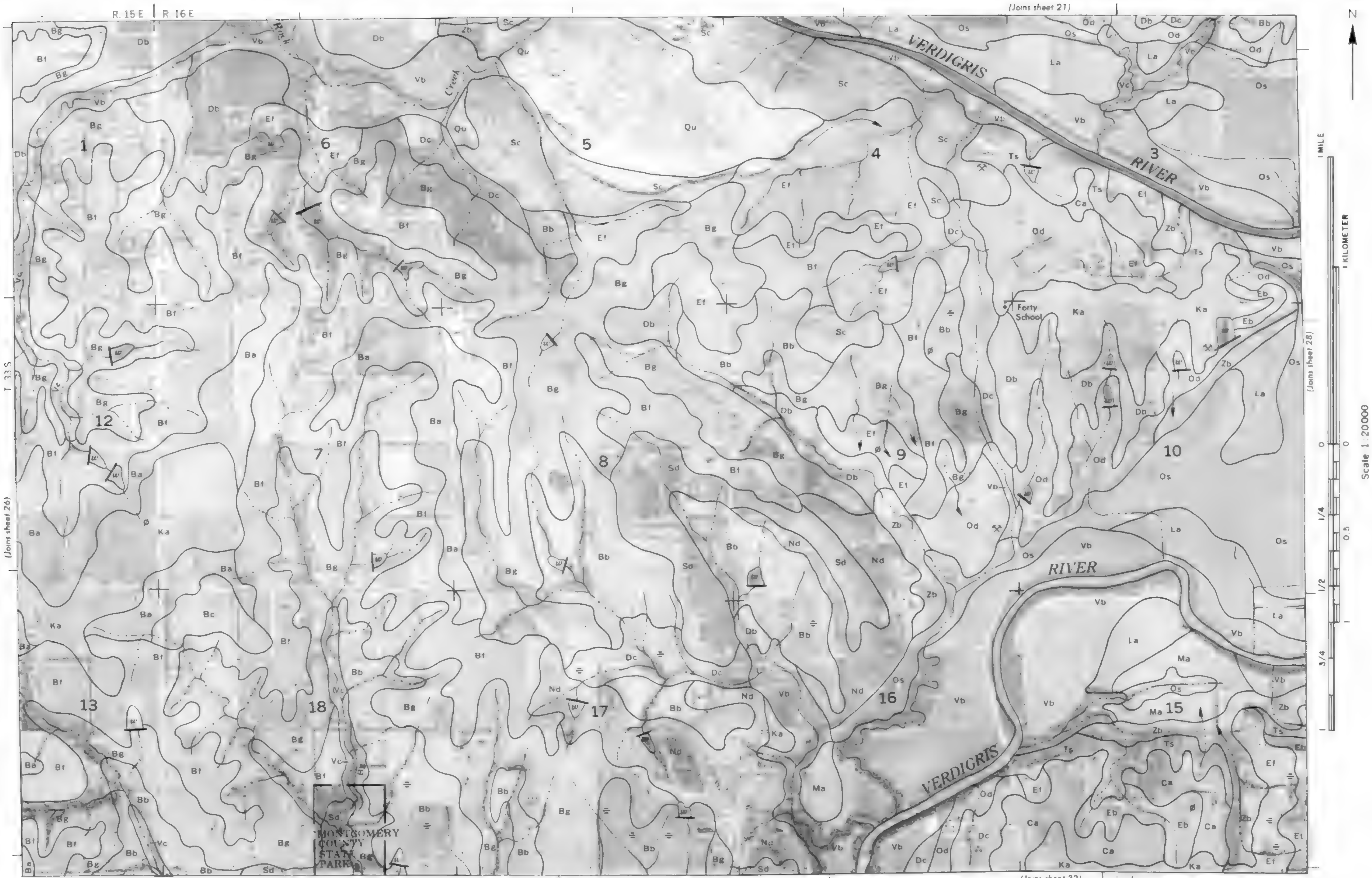

R. 17 E.
(Joins inset sheet 12)
T. 32 S.
(Joins sheet 22)
LABETTE COUNTY
(Joins upper right)
21
22
27
28
33
34
CENTENNIAL CEMETERY


23
N
R. 17 E.
(Joins lower left)
T. 33 S.
(Joins sheet 28)
LABETTE COUNTY
(Joins sheet 34)
3
4
9
10
15
16
1 MILE
1 KILOMETER
Scale 1:20000

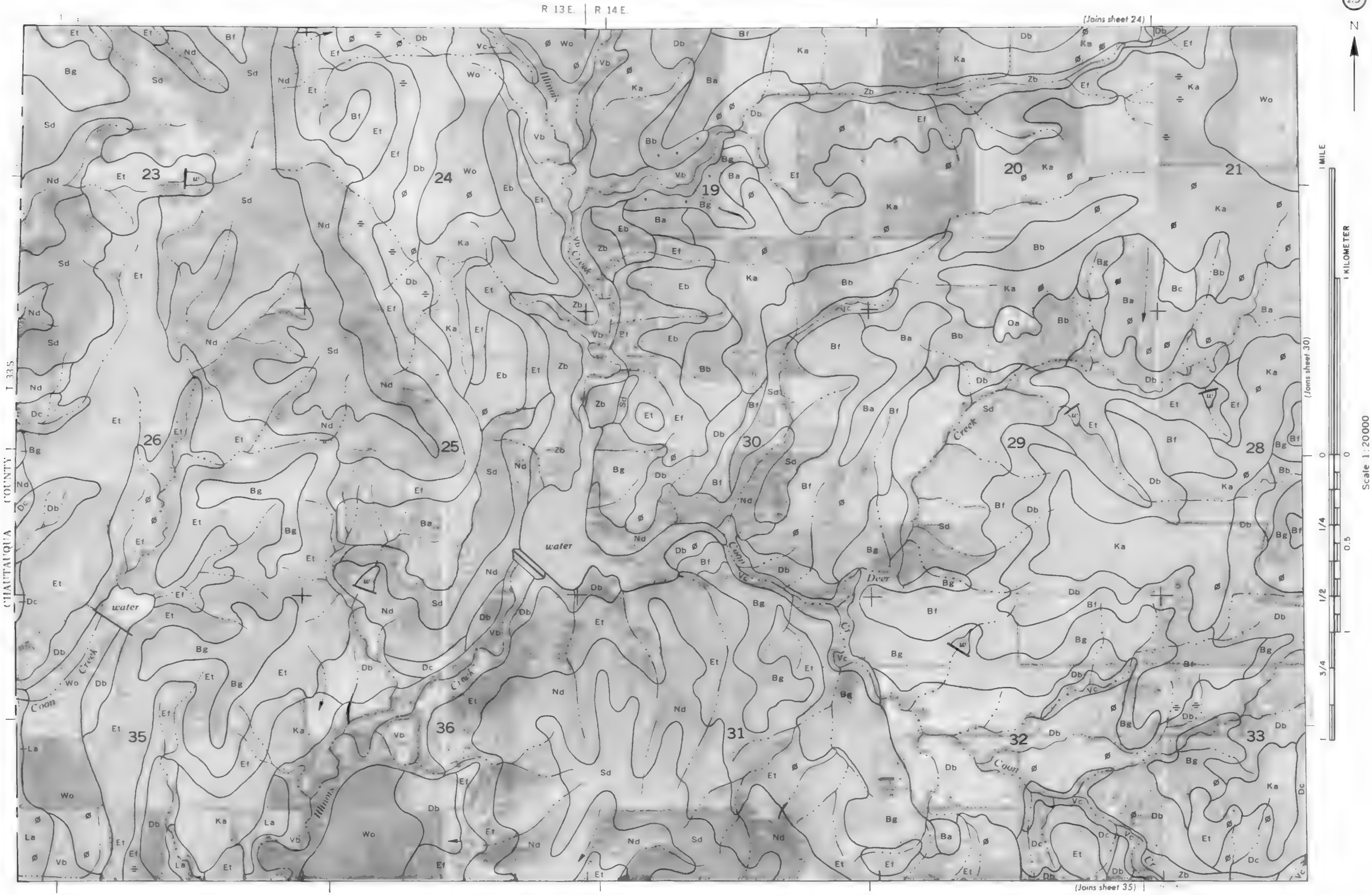

N
(Joins sheet 18)
R 13 E.
R 14 E.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
CHAUTAUQUA COUNTY
RUTLAND CEMETERY
Onion Creek
Illinois Creek
T 33 S
(Joins sheet 25)
(Joins sheet 29)

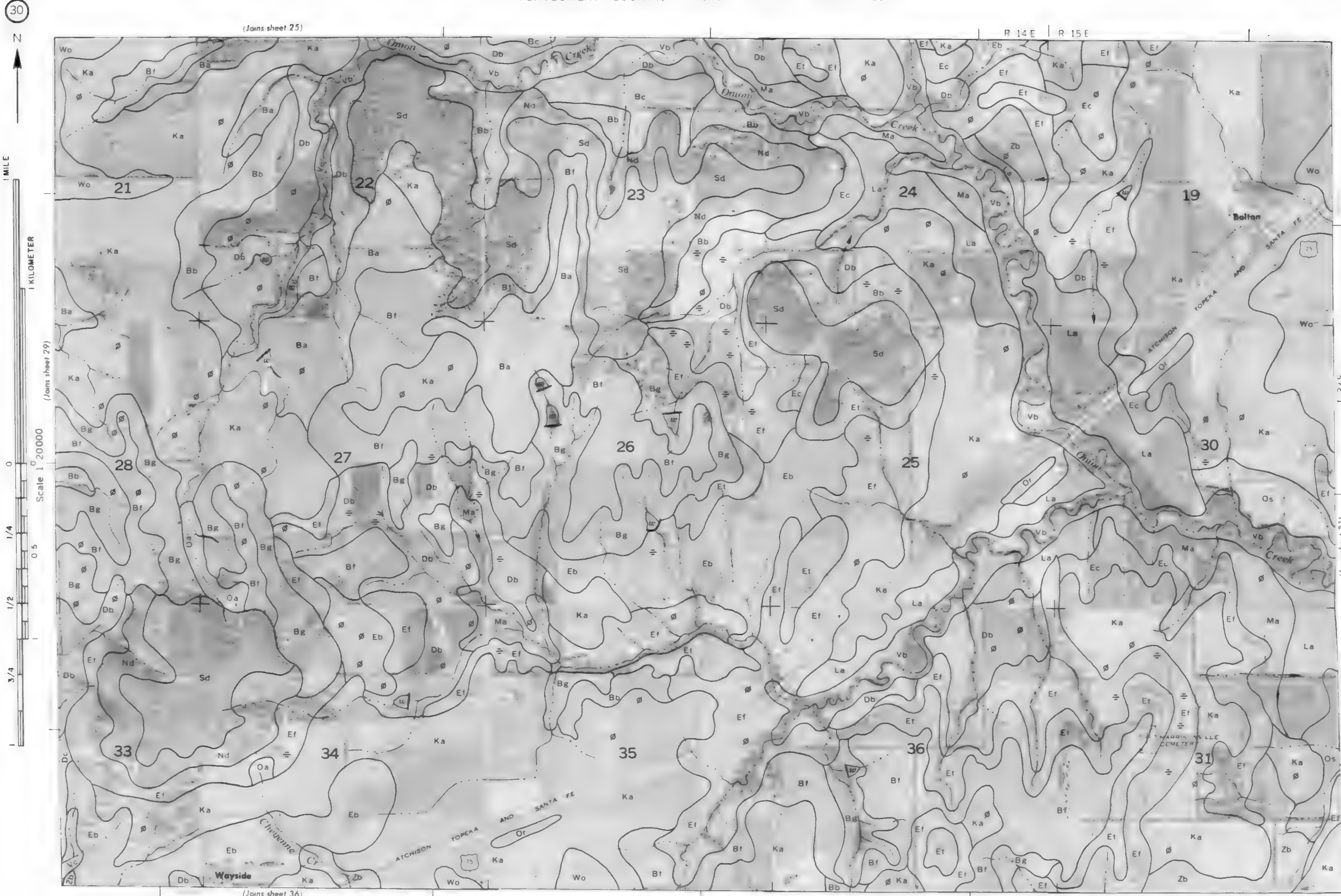

R. 14 E.
R. 15 E.
(Joins sheet 19)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 30)
HIGHLAND CENTER CEMETERY
Onion Creek
N
1 MILE
1 KILOMETER
Scale 1:20000


26
N
(Joins sheet 20)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 31)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
INDEPENDENCE
(county seat)
Rock Creek
SANTA FE
TOPEKA AND
ATCHISON
MISSOURI PACIFIC
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

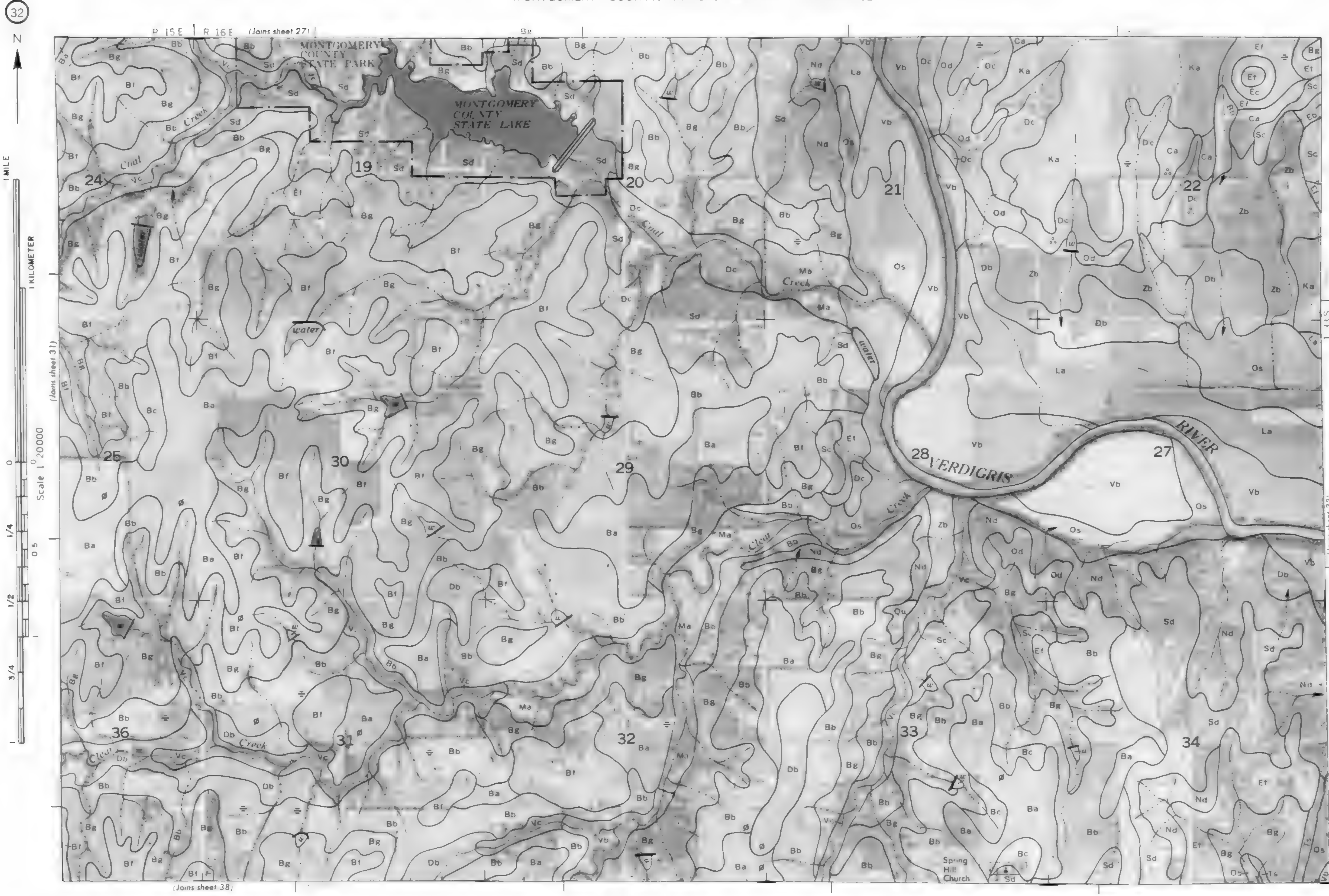

R. 15 E.
R. 16 E.
(Joins sheet 21)
(Joins sheet 28)
(Joins sheet 32)
(Joins sheet 26)
T. 33 S.
N
VERDIGRIS
RIVER
RIVER
VERDIGRIS
Rock Creek
Forty School
MONTGOMERY COUNTY STATE PARK
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


(Joins sheet 22)
R 16 E
R 17 E
(Joins sheet 27)
(Joins sheet 33)
(Joins inset, sheet 23)
T 33 S
VERDIGRIS
RIVER
N
1 MILE
1 KILOMETER
Scale 1:20000

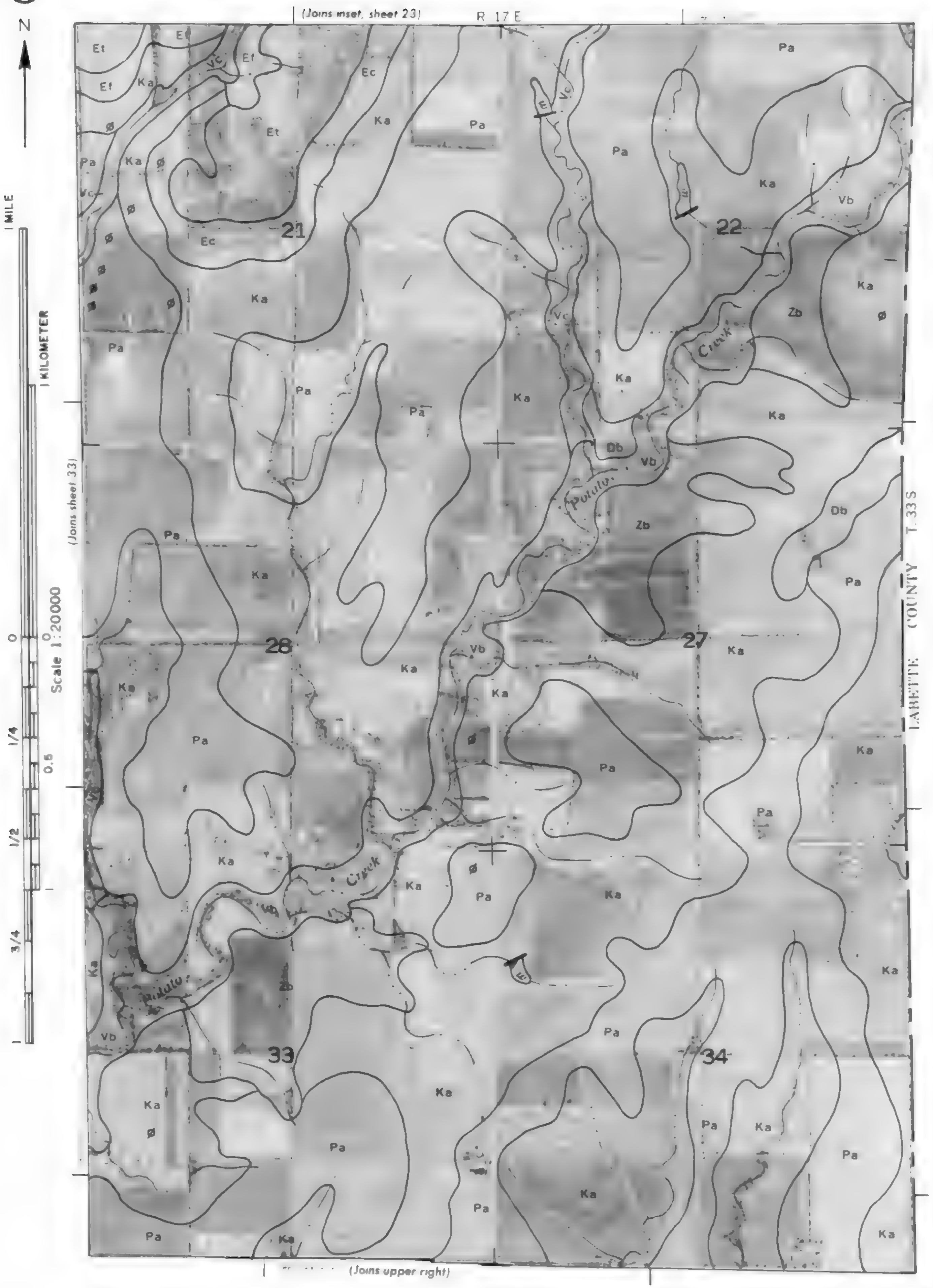

R 13 E.
R 14 E.
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 35)
T. 33 S.
CHAUTAUQUA COUNTY
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
water
Coon Creek
Deer Creek
Illinois
Vb Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


30
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
(Joins sheet 25)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 36)
R 14 E
R 15 E
34 S
Onion Creek
Cheyenne Cr.
ATCHISON TOPEKA AND SANTA FE
Bolton
Wayside
75
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31

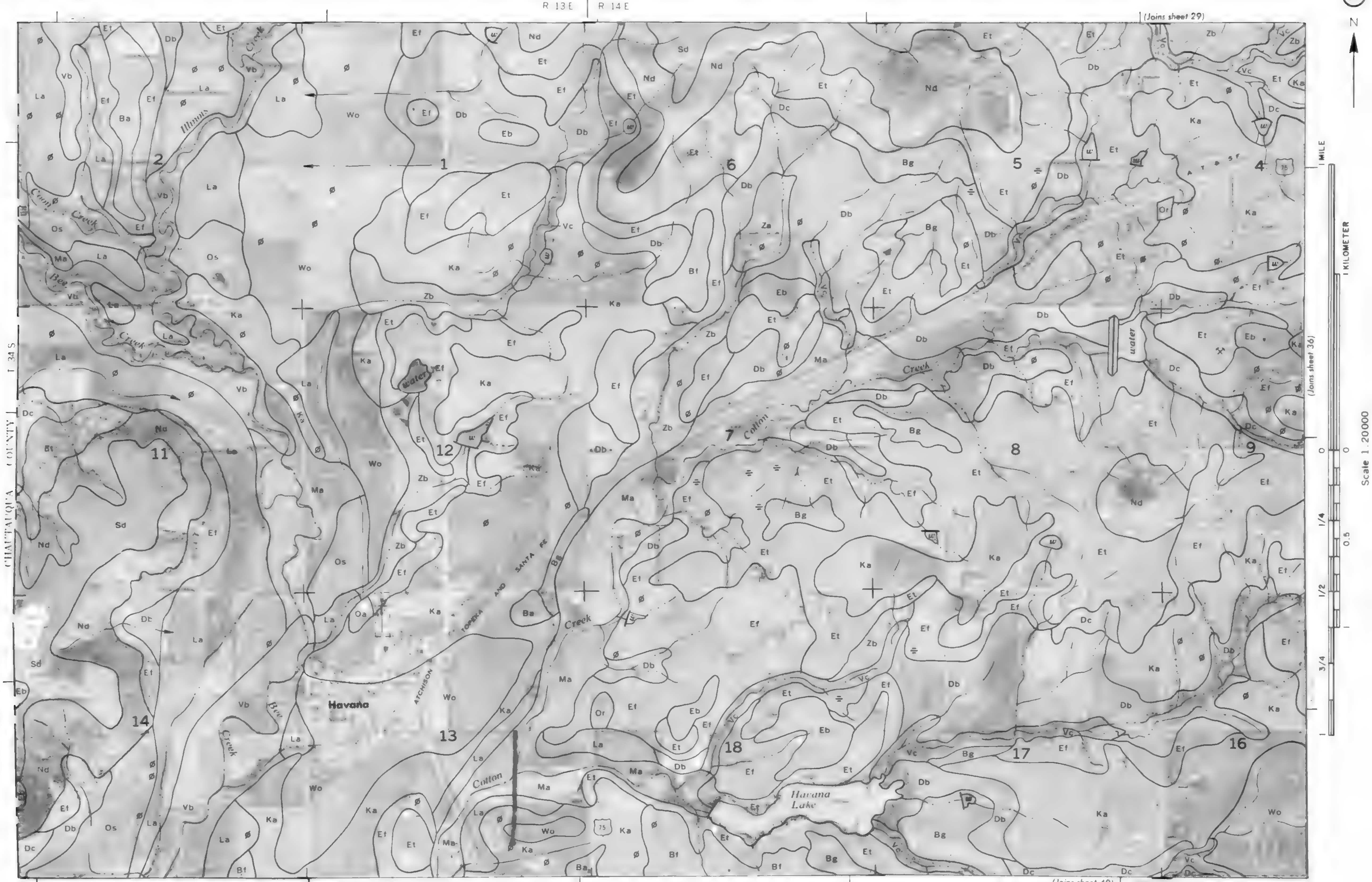

(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 37)
(Joins sheet 30)
R. 15 E.
T. 33 S.
N
Independence Municipal Airport
MISSOURI PACIFIC
Onion Creek
Coal Cr.
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

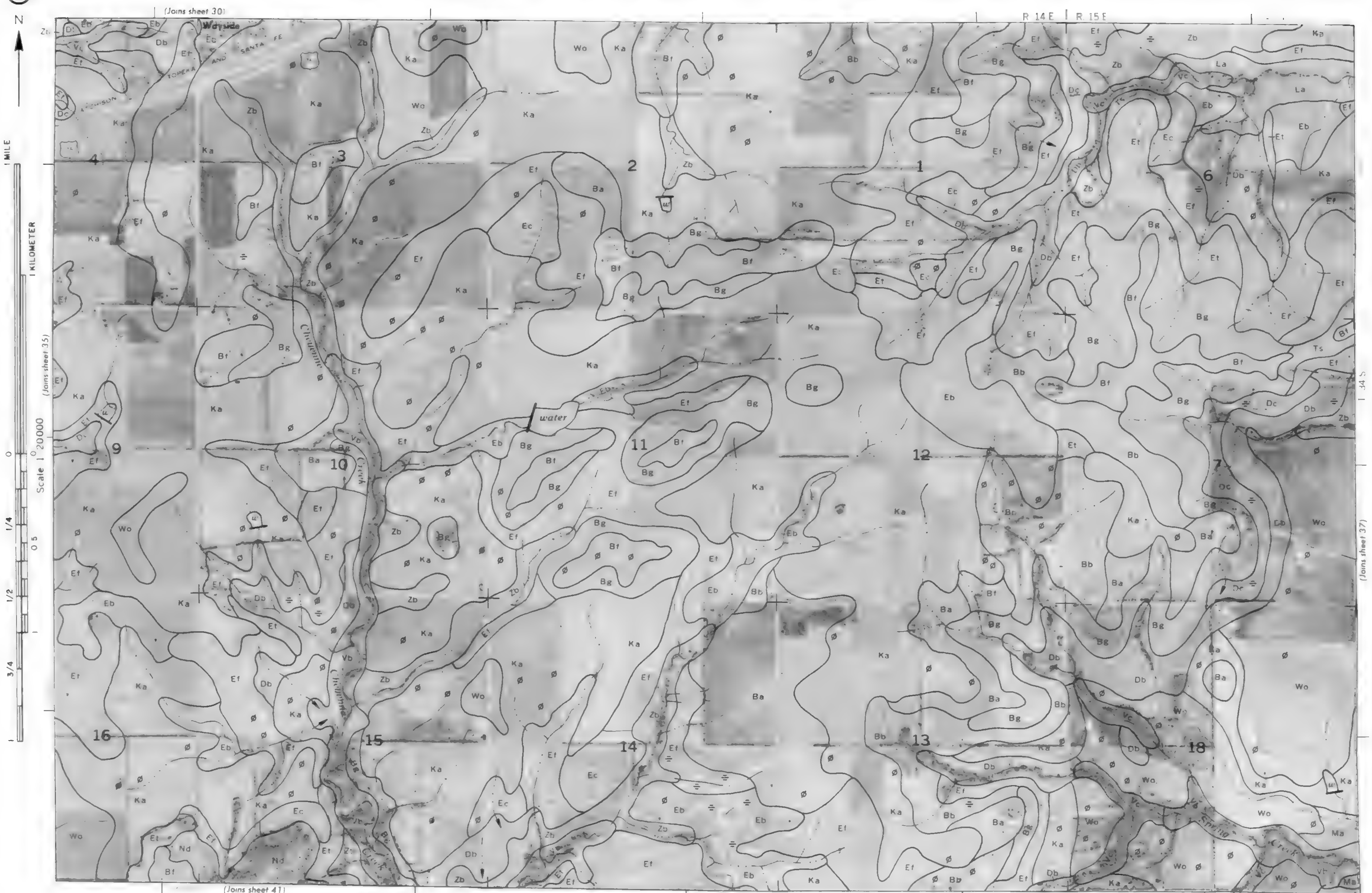

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
R. 15 E. | R. 16 E.
(Joins sheet 27)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 38)
T. 33 S.
MONTGOMERY COUNTY STATE PARK
MONTGOMERY COUNTY STATE LAKE
Coal Creek
Clear Creek
VERDIGRIS RIVER
water
Spring Hill Church
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

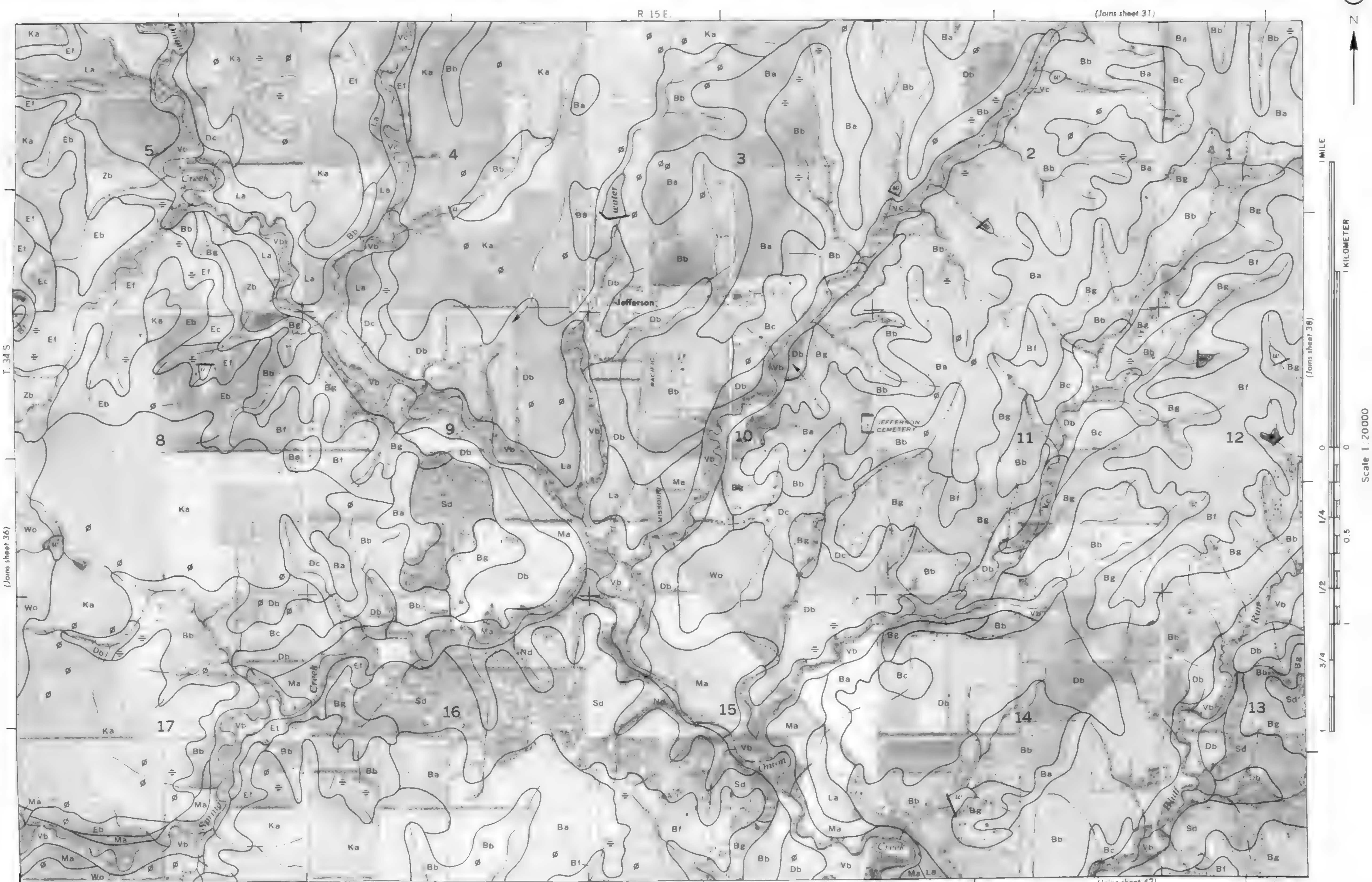

R 16 E
R 17 E
T 33 S
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 32)
(Joins sheet 39)
N
Liberty
Liberty Lakes
water
SEWAGE LAGOON
VERDIGRIS RIVER
Cotton Creek
Big Hill Creek
Potato Cr
ATCHISON TOPEKA AND SANTA FE
19
20
23
24
25
26
29
30
31
32
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

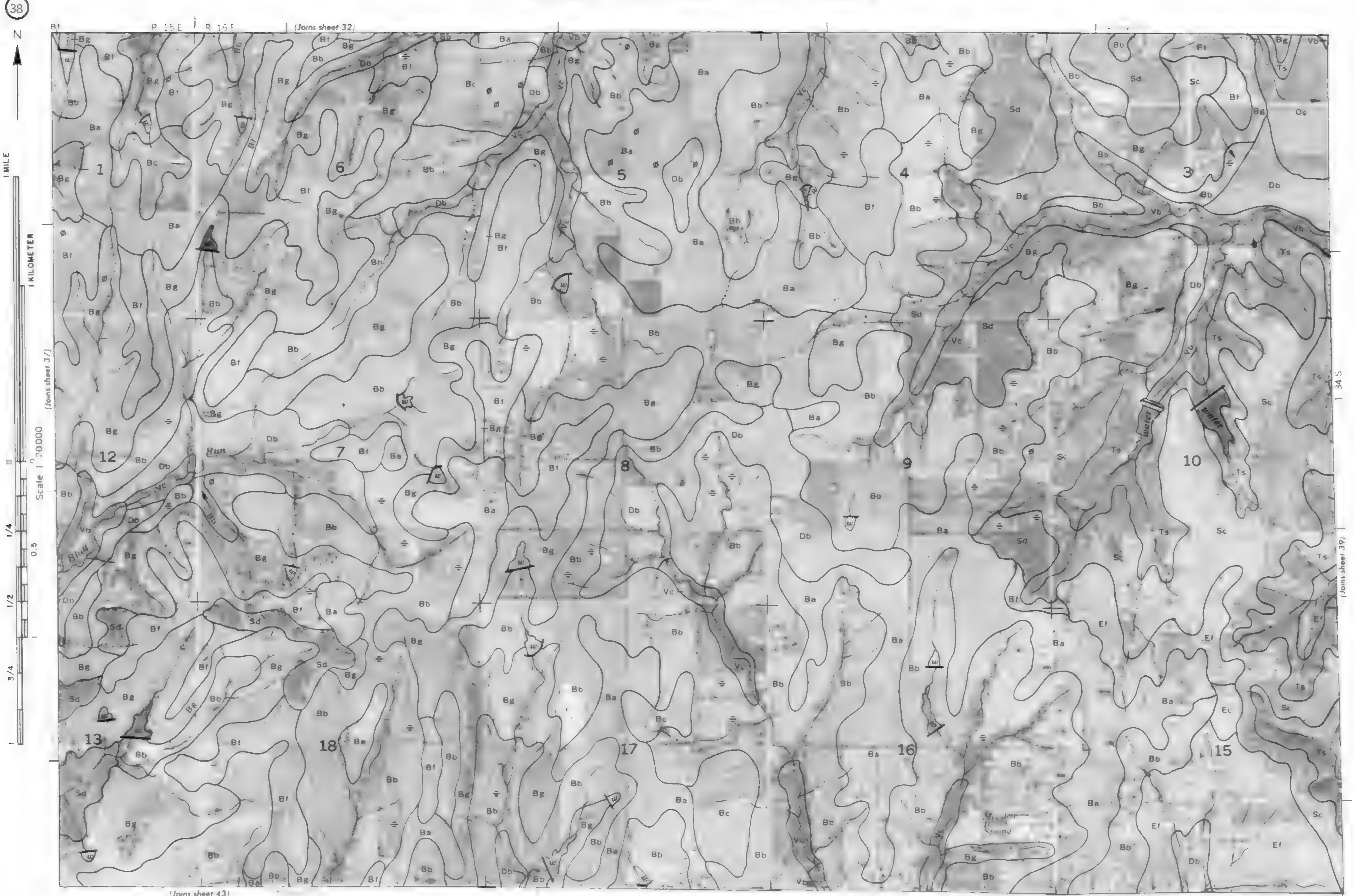

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
(Joins inset, sheet 23)
R 17 E
(Joins sheet 33)
T 33 S
LABETTE COUNTY
(Joins upper right)
Potato
Creek
21
22
27
28
33
34
Pa
Ka
Vc
Vb
Db
Zb
Et
Ec
Ef


(Joins lower left)
(Joins sheet 39)
T 34 S
LABETTE COUNTY
(Joins sheet 45)
Claymore
Creek
Spring
MISSOURI KANSAS TEXAS
3
4
9
10
15
16
Pa
Ka
Vc
Wo
Db
Zb
Et
Ba

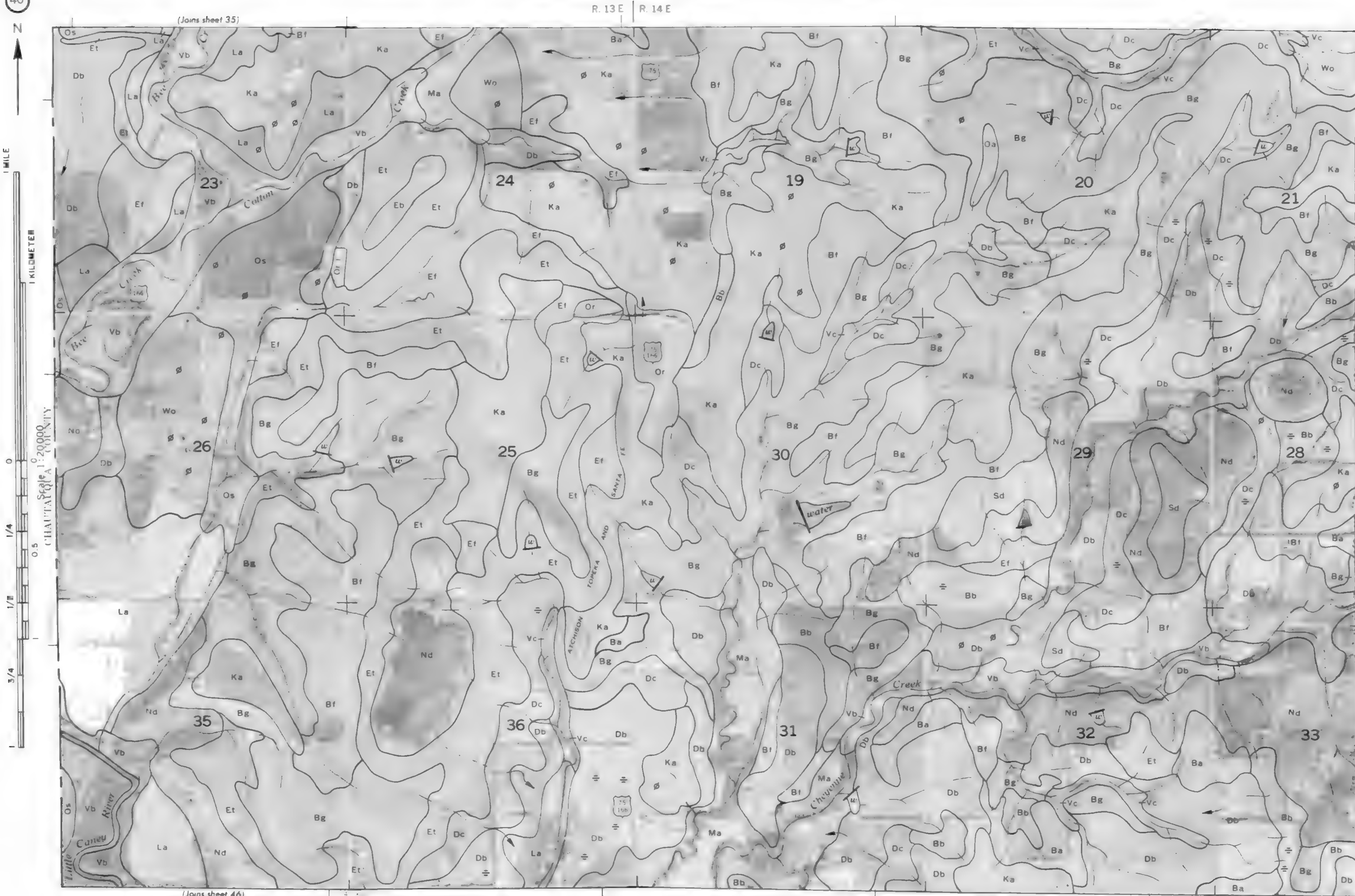

R 13 E
R 14 E
(Joins sheet 29)
(Joins sheet 36)
(Joins sheet 40)
T 34 S
CHAUTAUQUA COUNTY
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Havana
Havana Lake
Cotton Creek
Bee Creek
Illinois Creek
Coon Creek
ATCHISON TOPEKA AND SANTA FE


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
(Joins sheet 30)
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 41)
R 14 E
R 15 E
T 34 S
Wayside
ATCHISON TOPEKA AND SANTA FE
Cheyenne Creek
Spring Creek
water


R 15 E.
(Joins sheet 31)
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 42)
T. 34 S.
N
Jefferson
JEFFERSON CEMETERY
MISSOURI PACIFIC
Onion Creek
Creek
water
Spring Creek
Bluff Run
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


38
N
R 15 E
R 16 E
(Joins sheet 32)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 43)
T 34 S
1 MILE
1 KILOMETER
Scale 1:20000
water


R. 16 E.
R. 17 E.
(Joins sheet 33)
(Joins inset, sheet 34)
(Joins sheet 44)
(Joins sheet 38)
N
VERDIGRIS
RIVER
Potato Creek
Big Hill Creek
Spring Cr.
Claymore Creek
intermittent
ATCHISON TOPEKA AND SANTA FE
McGugin Field
Avian
169
1
2
5
6
7
8
11
12
13
14
17
18
Os
Vb
Db
Dc
Od
Pa
Ka
Eu
La
Sc
Ts
Ef
Vc
Wo
Or
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


R. 13 E
R. 14 E
(Joins sheet 35)
(Joins sheet 46)
(Joins sheet 41)
T. 34 S
N
1 MILE
1 KILOMETER
Scale 1:20000
CHAUTAUQUA COUNTY
Bee Creek
Cotton Creek
Little Caney River
Cheyenne Creek
ATCHISON TOPEKA AND SANTA FE
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

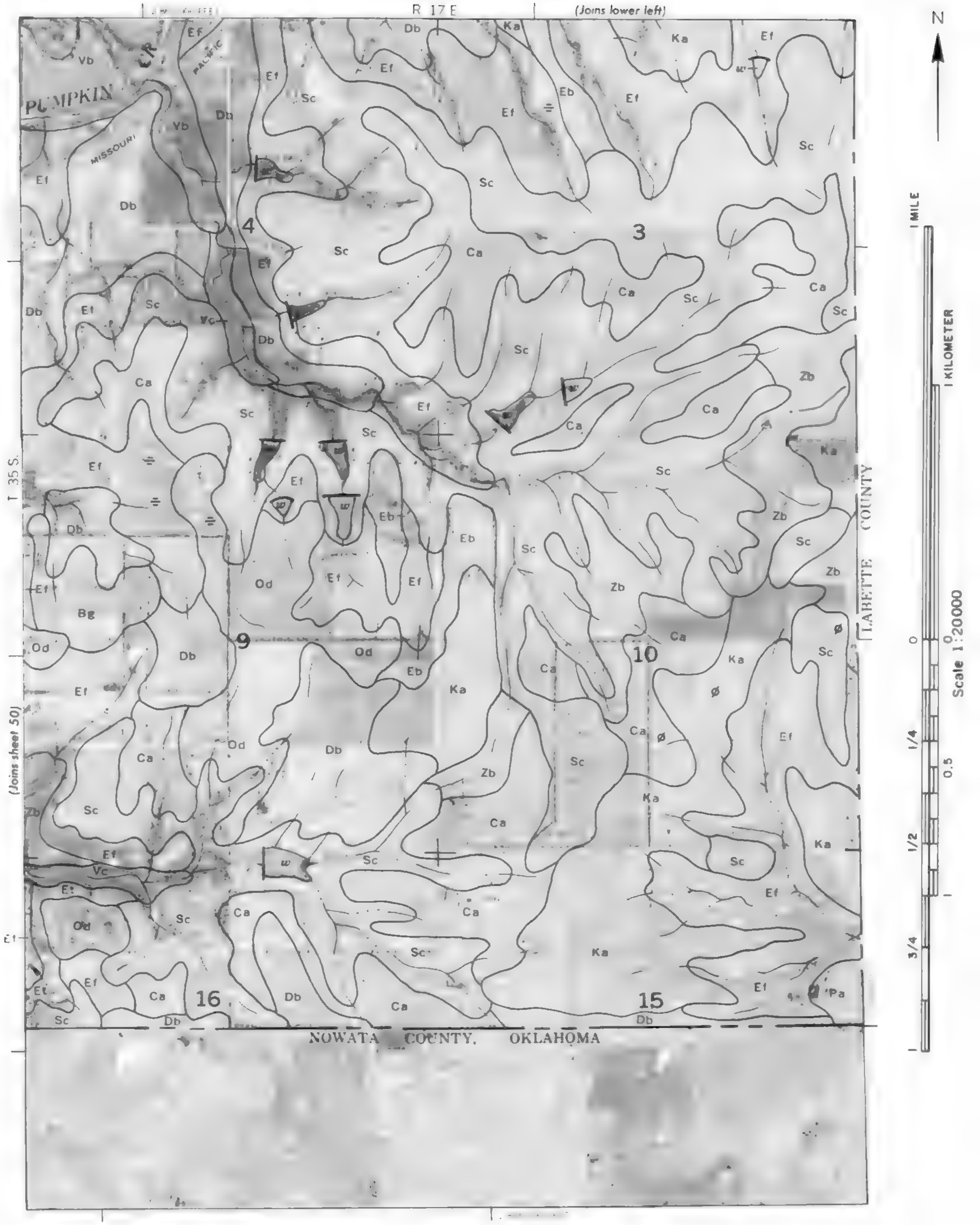

(Joins sheet 36)
(Joins sheet 42)
(Joins sheet 40)
(Joins sheet 47)
1 MILE
1 KILOMETER
Scale 1:20000
19
21
22
23
24
25
26
27
28
30
31
33
34
35
36
Tyro
water


N
(Joins sheet 37)
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 48)
1 MILE
1 KILOMETER
Scale 1:20000
Fawn Creek
Onion Creek
Bluff Run
Deadman
MISSOURI PACIFIC
PIONEER CEMETERY

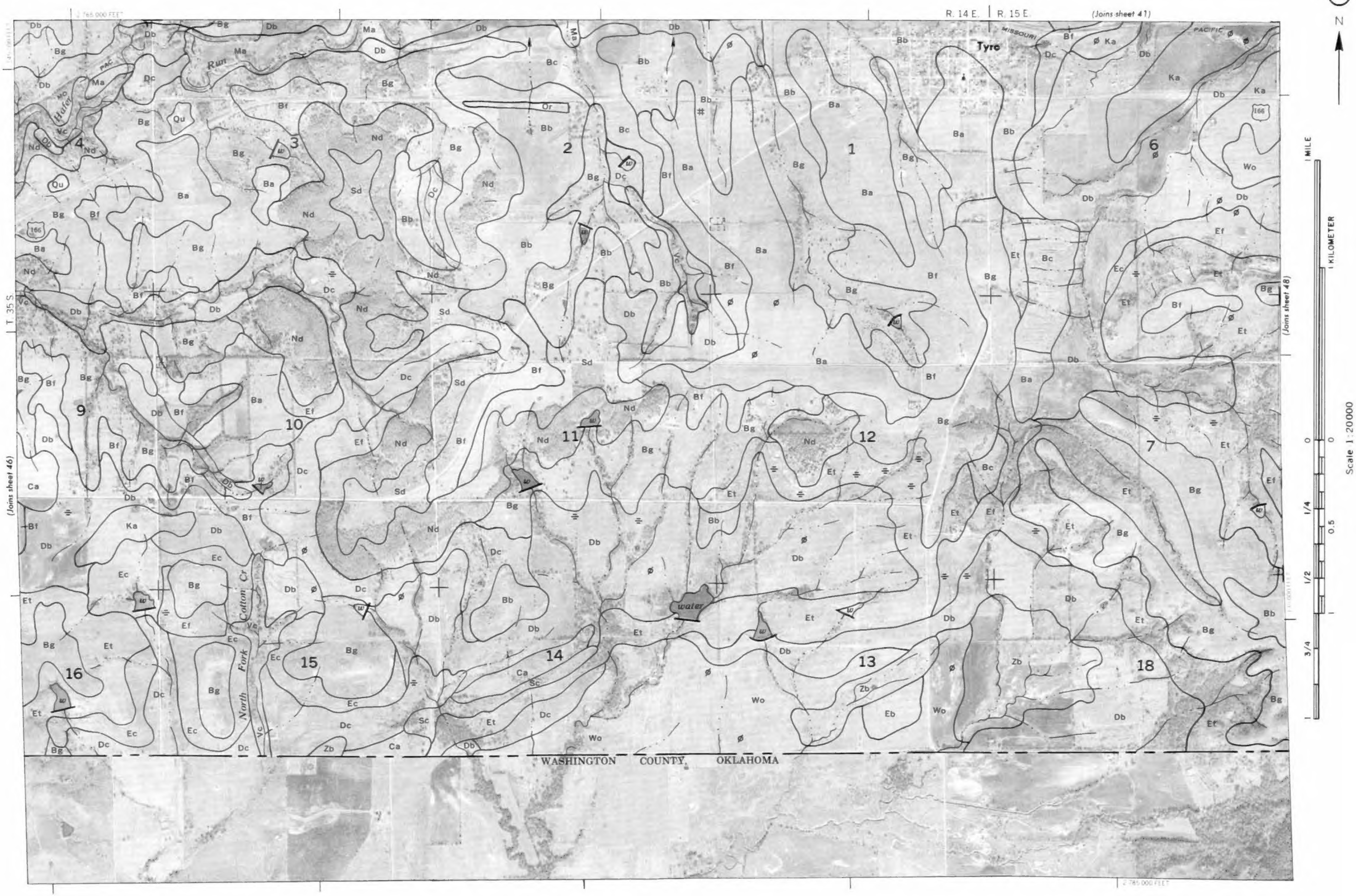

43
R. 15 E.
R. 16 E.
T. 34 S.
(Joins sheet 38)
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 49)
Indian Village
Cedar Bluff School
Dearing
West Coffeyville
COFFEYVILLE
Sycamore Cr.
Onion Creek
CALVARY CEMETERY
FAIRVIEW CEMETERY
RESTLAWN CEMETERY
water
1 MILE
1 KILOMETER
Scale 1:20000
2 835 000 FEET

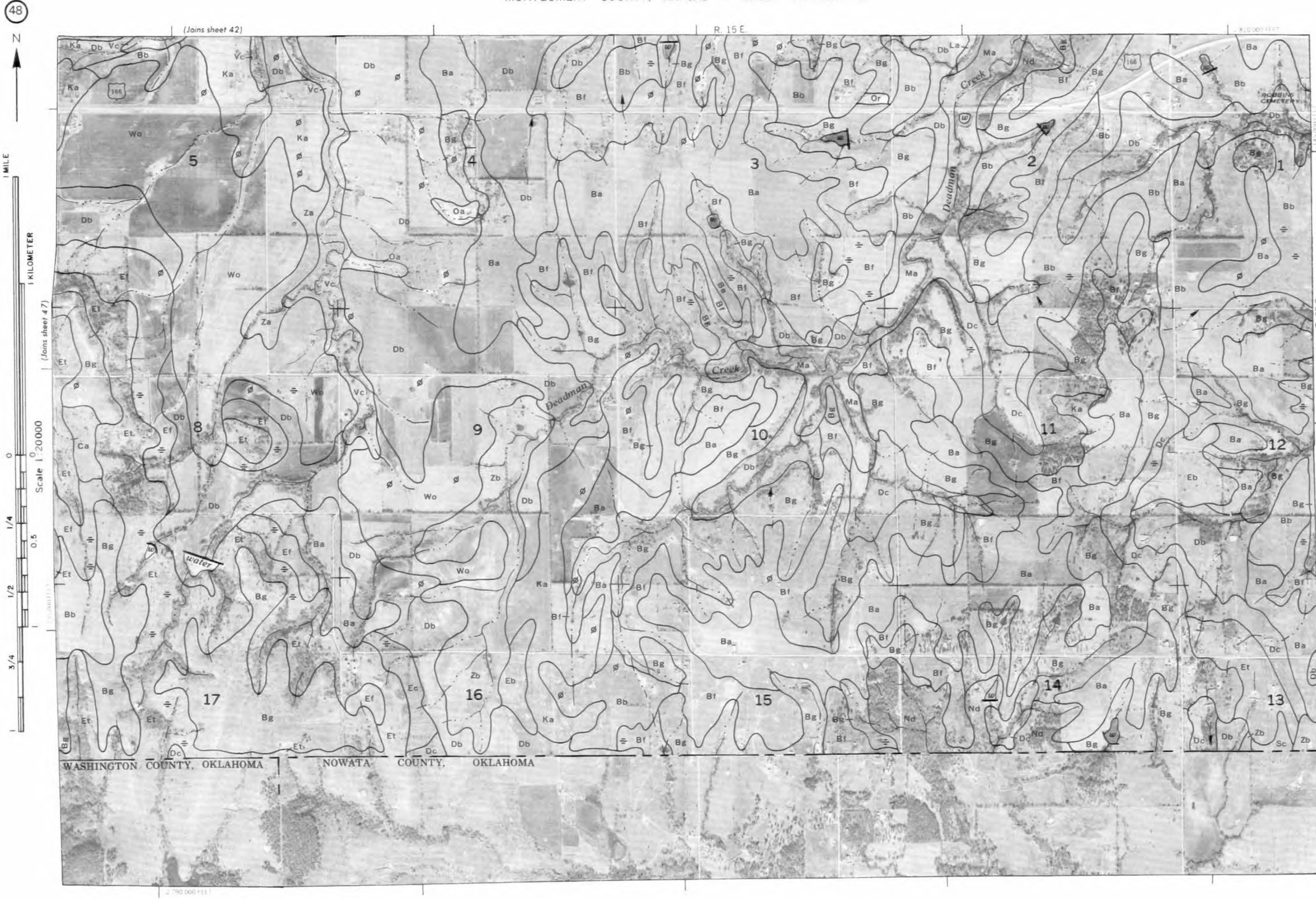

44
N
(Joins sheet 39)
R 16 E
R 17 E
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 50)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
VERDIGRIS
RIVER
Claymore School
KALLOCK CEMETERY
Claymore
PUMPKIN
CREEK
ATCHISON TOPEKA AND SANTA FE
MISSOURI KANSAS TEXAS
MISSOURI PACIFIC
COFFEYVILLE
169
166
19
20
23
24
25
26
29
30
31
32
35
36

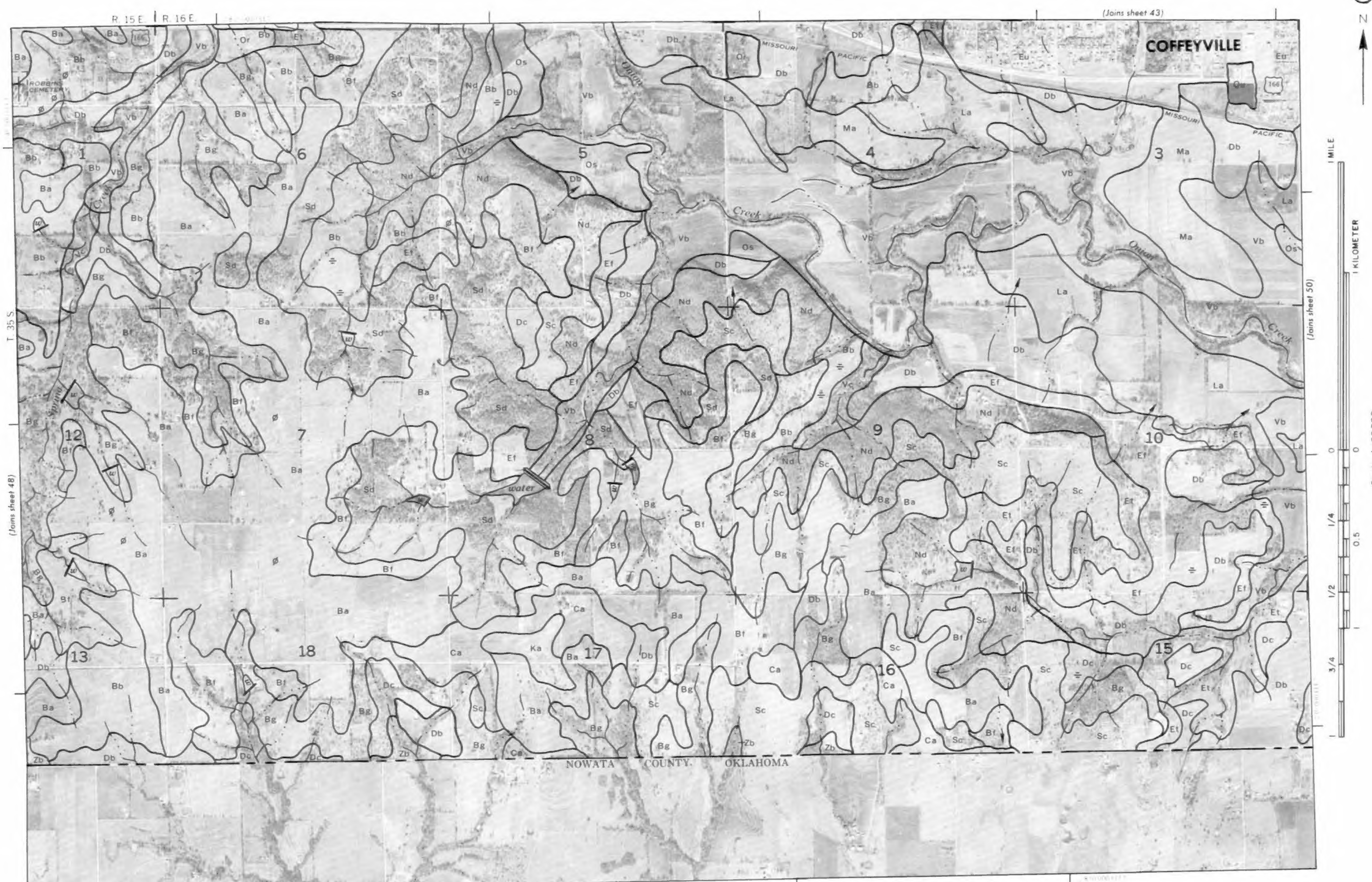

R 17 E
(Joins inset, sheet 34)
(Joins sheet 44)
T 34 S
(Joins upper right)
2 865 000 FEET
LABETTE COUNTY
Hunter
UNION CEMETERY
MISSOURI KANSAS TEXAS
MISSOURI PACIFIC
PUMPKIN CREEK
water
21
22
27
28
33
34
166

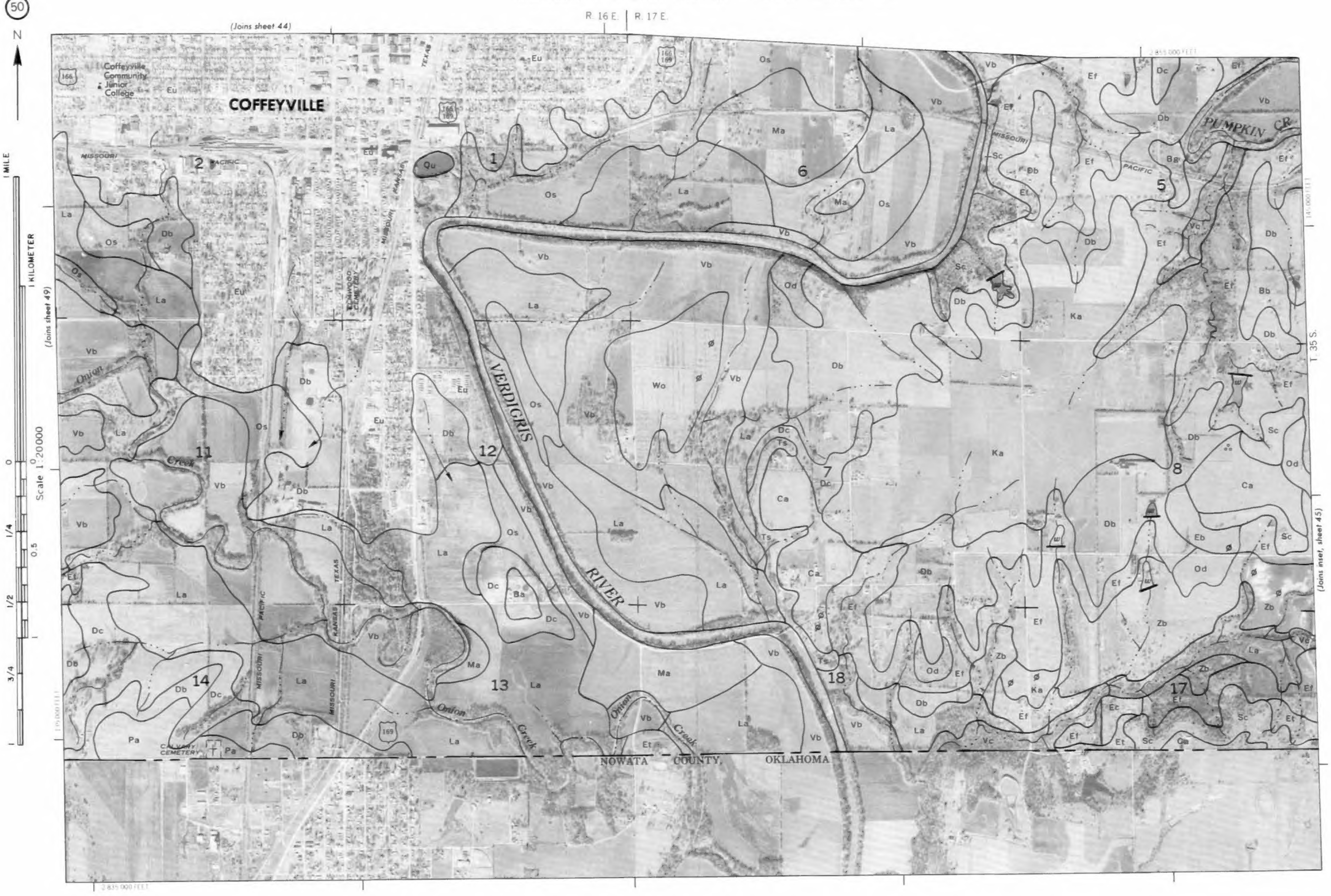

R 17 E
(Joins lower left)
(Joins sheet 50)
T 35 S
PUMPKIN CR
MISSOURI PACIFIC
LABETTE COUNTY
NOWATA COUNTY, OKLAHOMA
3
4
9
10
15
16
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1


46
N
(Joins sheet 40)
(Joins sheet 47)
WASHINGTON COUNTY OKLAHOMA
CANEY
Mud Creek
Little Caney River
water
1 MILE
1 KILOMETER
Scale 1:20000
1/4
1/2
3/4
0.5


47
N
R. 14 E.
R. 15 E.
(Joins sheet 41)
(Joins sheet 46)
(Joins sheet 48)
T. 35 S.
2 765 000 FEET
2 785 000 FEET
Tyro
MISSOURI
PACIFIC
Run
Cotton Cr
North Fork
water
WASHINGTON COUNTY, OKLAHOMA
166
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:20000


48
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 42)
R. 15 E.
T. 35 S.
(Joins sheet 47)
(Joins sheet 49)
Deadman Creek
ROBBINS CEMETERY
water
WASHINGTON COUNTY, OKLAHOMA
NOWATA COUNTY, OKLAHOMA


49
N
(Joins sheet 43)
(Joins sheet 48)
(Joins sheet 50)
R. 15 E.
R. 16 E.
T. 35 S.
COFFEYVILLE
MISSOURI PACIFIC
ROBBINS CEMETERY
Onion Creek
NOWATA COUNTY, OKLAHOMA
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


50
N
(Joins sheet 44)
R. 16 E.
R. 17 E.
Coffeyville Community Junior College
COFFEYVILLE
MISSOURI PACIFIC
TEXAS
KANSAS
ELMWOOD CEMETERY
VERDIGRIS
RIVER
PUMPKIN CR
Onion Creek
CALVARY CEMETERY
NOWATA COUNTY, OKLAHOMA
(Joins sheet 49)
(Joins inset, sheet 45)
T. 35 S.
2 855 000 FEET
2 835 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5